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THE GEOGRAPHICAL JOURNAL

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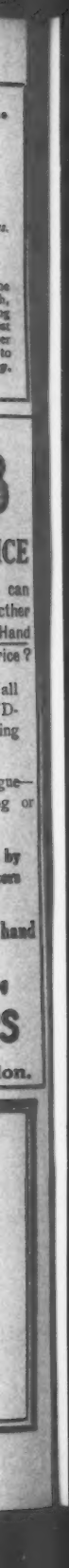


The Geographical Journal

Vol. LX No. 4 October 1922

BORDER COUNTRIES OF THE PUNJAB HIMALAYA

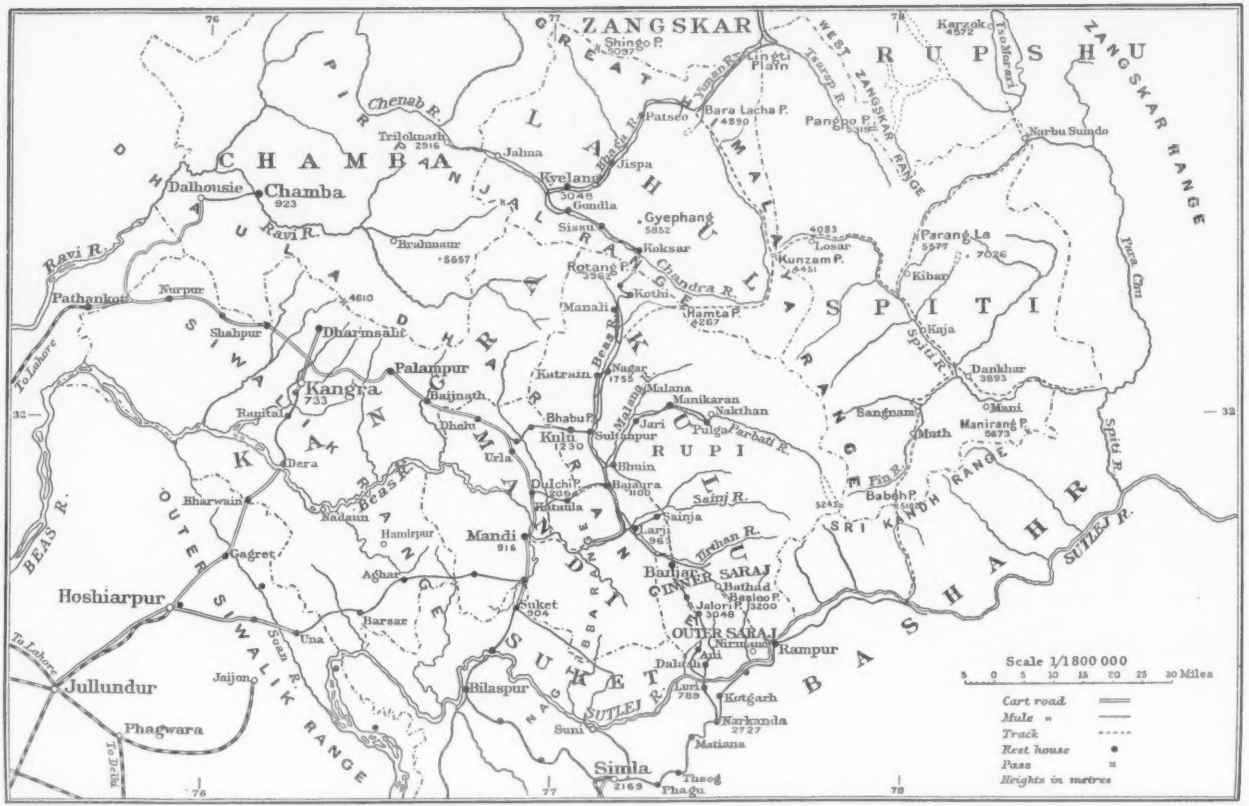
H. Lee Shuttleworth, I.C.S.

Read at the Meeting of the Society, 22 May 1922.

NORTH of the Sutlej river the only tract of British India that touches the Nari Khorsum province of independent Tibet is Spiti, the easternmost Waziri of the Kulu subdivision of the Kangra District in the Punjab. While Spiti is described in the Imperial Gazetteer as being beyond question the most inaccessible part of the British dominions in India, Hindu writers of the past regarded Kulu as the end of the habitable world. In the seventh century A.D. the Chinese pilgrim Hiuen Tsiang penetrated to Kulu and gave a brief and accurate description of it. But he turned plainwards after hearing in Kulu stories of the dangers and precipices of the road north to Lahul.

These three geographically distinct countries of Kulu, Lahul, and Spiti form an administrative unit covering some 6607 square miles of entirely mountainous country. The area is thus considerably greater than Wales, and the latitude corresponds to that of Palestine, but the sea is more than 800 miles away. The population is small—about 125,000—and is composed of the most diverse elements, representing Aryan, Mongolian, and what we may perhaps call survivals of a very early Himalayan race. At least ten languages or dialects belonging to three separate linguistic groups are spoken. In a region where elevation varies from 2590 feet on the Sutlej to 23,050 feet in Spiti, and which spreads over the whole breadth of the Himalayan system of granite and crystalline ranges and even intrudes well into the sedimentary formations of the Tibetan zone, we find an extraordinary diversity of climate, vegetation, and fauna ranging from the sub-tropical to the arctic. In fact, in our small section of the Western Himalaya so rich is the variety in whatever field of study we are engaged, that we are tempted to linger in this valley or that, instead of dealing with our subject on wider lines. Even so, we must now limit our attention in the main to a few selected valleys out of many, perhaps equally beautiful and interesting.

The Sub-Himalaya of Kangra.—Let us approach the Himalaya from the Jullundur Doab. We first cross the low outer Siwalik range, composed


ZANGSKAR
RUPSHU
ZANGSKAR RANGE
CHAMBA
LAHUL
SPITI
KULU
RUPI
KANGRA
DHAULADHAR RANGE
PIR PANJAL RANGE
GREAT HIMALAYAN RANGE
WEST ZANGSKAR RANGE
SRI KANDH RANGE
BARA BANGAHAL RANGE
OUTER SIMLA RANGE
OUTER SARAJ
INNER SARAJ
BASHAHR
SUKET
Dalhousie
Chamba
Pathankot
Kangra
Palampur
Dharmsala
Shahpur
Nurpur
Baijnath
Dhelu
Urla
Dera
Bharwain
Nadaun
Hamirpur
Gagret
Hoshiarpur
Una
Jullundur
Jaijon
Phagwara
Mandi
Aghar
Suket
Barsar
Bilaspur
Suni
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Theog
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Manirang P.
Muth
Sangnam
Dankhar
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Kibar
Parang La
Kunzam P.
Losar
Gyephang
Kyelang
Jispa
Patseo
Bara Lacha P.
Shingo P.
Ingti Flain
Karzok
Tso Morari
Narbu Sumdo
Pangno P.
Tsarap R.
Zanskar R.
Lingti R.
Chenab R.
Ravi R.
Beas R.
Sutlej R.
Spiti R.
Parahio R.
Chandra R.
Bhaga R.
Malana R.
Tirthan R.
Sainj R.
Sirsa R.
Soan R.
To Lahore
To Jutogh
Trilokinath 2916
Jahna
Gondla
Sissu
Koksar
Brahmaur 5657
Rotang P. 3962
Kothi
Manali
Hamta P. 4267
Kutrain
Nagar 1755
Malana
Manikaran
Nakthan
Bhabu P.
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Sultanpur
Pulga
Tarbati R.
Bhuin
Dulchi P. 2094
Banjara 1100
Fotaula
Sainja
Larji 961
Bathad
Jalori P. 3200
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of rapidly disintegrating sediments of Tertiary Age, which contain a few fossils of recent animal forms. Soon we see faintly on the north-eastern horizon the long line of the granite snow-capped Dhaola Dhar, towering far above the low conglomerate and soft sandstone Kangra hills. This romantic and beautiful Kangra country is everywhere dotted with mediæval temples and high-perched castles. It consists of a series of parallel pine-clad ridges and small dales running north-west to south-east and into the Beas and Sutlej. In the 45 miles between the Jaswan Dun, just inside the outer Siwaliks, and the Kangra valley at the foot of the Dhaola Dhar we traverse three main lines of hills, not higher than 4000 feet at their loftiest points. The inhabitants are old-world Hindu Rajputs and other Hindu tribes, but now and then we encounter a Buddhist lama from some monastery beyond the snows on his way to the holy places associated with the life of the Lord Buddha. Five days' marching brings us to the Kangra tea gardens, behind which the Dhaola Dhar rises abruptly for an apparantly sheer 13,000 feet. Here the rainfall averages well over 100 inches a year; 116 inches is the Dharmsala average, but sometimes 9 and 10 inches a day and 160 inches a year are recorded. The range is crossed by the Indrahar, 14,150 feet high, and other passes. On the north-east face the slopes are less steep. Here in Chamba State is the basin of the Ravi, near the headwaters of which rises the Brahmaur Kailas peak, which is said to be Mahadev's summer retreat. Lahul and Kulu, on the upper Chenab and Beas respectively, lie further to the east beyond a still loftier mountain range than the outer Dhaola Dhar.

Boundaries, and Mountain Barrier between Kulu and Spiti.—A reference to the map will show how the Kulu subdivision, which marches with Tibet in the east, is elsewhere almost completely hemmed in by Native States. On the north come the Western Tibetan countries of Zangskar and Rupshu under the Maharaja of Jammu and Kashmir. South along the Sutlej stretches Bashahr State, while on the west the Chamba and Mandi States all but isolate Kulu from the rest of British India. Kulu proper occupies some 1912 square miles on the upper Beas and includes a small area, Outer Saraj, on the north side of the Sutlej. It is inhabited, with one striking exception, by peoples speaking Indo-European dialects, belonging to the Kulu and Sutlej Pahari groups. To the east the Great Himalaya forms a complete linguistic and ethnological divide, besides being a natural watershed. Beyond lies Tibetan Spiti, which is within the geological Tibetan zone. To the north the Pir Panjal westerly offshoot from the Great Himalaya cuts off Kulu from its north Waziri, Lahul. Kulu has access to its two dependencies only by passes closed for half the year, over ranges averaging over 18,000 feet in height.

From Mandi and the Sutlej Kulu is approached by passes 6740, 9480, and 10,000 feet high, of which only the first, the Dulchi, is open to mule traffic for most of the year. Communication between Spiti and Tibet, and

Lahul and Chamba, however, is easy and rarely closed by snow for long. The Spiti river runs east away from the plains before it turns south into the Sutlej, and it is remarkable that not a single river cuts its way through the Great Himalaya between the Sutlej and Indus, a distance of 360 miles. There is no gap between Kulu and Spiti so low as the Zogi-la, 11,300 feet high, that connects Ladakh with Kashmir. The lowest so far explored, but hardly ever used, is 17,200 feet high, and will be described later. The usual routes to Spiti are *viâ* the Chandra valley or by the Sutlej, both involving considerably détours. While the Spiti river drains into the Sutlej, the Tsarap carries the waters of the north part of Spiti and of Lahul beyond the Baralacha into the Indus.

A tongue of Spiti territory extends north-east beyond the Zangskar or Paralasa range into the lofty plain south of Tso Morari, the westernmost of the numerous elevated lakes found in the Tibetan zone.

Scope of this Paper.—I propose in this paper, after a brief glimpse at the well-known Kulu valley, which in rich beauty and grandeur is inferior to no other Himalayan country, to ask you to accompany my wife and myself from Nagar, our Kulu headquarters, east to Tso Morari. We shall linger awhile in the Malana glen, visited by General Bruce in 1912, ascend to the hitherto incorrectly mapped head of the Parbati, and cross into the Pin valley of Spiti by a pass never before, I believe, crossed in this direction by any European. Then, after a visit to the main Spiti valley, we shall reach Tso Morari by the Parang-la. Returning over the Pangpo-la, also on the Zangskar range, we shall find our way back to Kulu *viâ* Lahul. During this return journey we shall see the Tsarap tributary of the Indus and the sources of the Chenab. The vast district of Kangra, which includes Kulu, contributes something to every great river of the Punjab plains, with the sole exception of the Jhelum. Our journey will lead us over 490 miles, and will, I hope, give a fair general idea of the rivers, glaciers, and mountain barriers of this part of the Himalaya, besides bringing us into contact with some of its diverse human communities.

The Kulu Beas Valley.—Instead of entering Kulu from Mandi by the present routes over two lines of hills, let us follow the gorge through which the Beas escapes at Largi into the sub-Himalayan region. Here a motor road is being laboriously blasted out along the precipitous faces of rock that overhang the river. At Bajaura we enter the foot of the Kulu valley, here a verdant open dale with numerous small hamlets amid fields that are covered with rich crops of wheat, barley, mustard, and the opium poppy in spring, and with maize, rice, amaranth, and many pulses in the autumn. On either side of the valley rise gentle slopes luxuriant with a wealth of varied forest growth up to above 11,000 feet. The banks and islets of the Beas are densely wooded with alder thickets (*Alnus nepalensis*). On the hills forests of three main varieties of mountain oak, deodar, blue

THE UPPER BEAS VALLEY IN KULU FROM NAGAR

AN UPPER KULU SHEEP RUN IN SILVER FIR AND SPRUCE FOREST

SNOWFIELD AT HEAD OF PARBATI, AND PASS TO THE PIN IN SPITI

THE PARBATI MORAINE FROM 13,520 FEET

pine, spruce, silver fir, ash, and silver birch present to the view masses of varying depths of green. Walnut, horse-chestnut, maple, elm, mulberry, and in the Parbati the chil pine are also found. At about 5000 feet the giant tree rhododendron (*R. arboreum*) attains a height of over 40 feet, and, just beyond the birches 6000 feet above the red rhododendron, the mauve shrub rhododendron (*R. campanulatum*) flowers even before the snow melts. The abundance of wild flowers in the dales, forests, and especially above the snow line defies all verbal description. Perhaps among the most striking of the Alpine flowers are the blue Himalayan poppy, the yellow violet, the beds of mottled iris, and the numerous clumps of primulas, but the masses of variegated colour that in the rains adorn the high sheep runs or *thaches* impress one most. The wild fruit trees, apple, pear, peach, apricot, cherry, currant, raspberry, and walnut, and the recently introduced European and American varieties in the fruit gardens are an important economic feature of Kulu. Fruit does well, as the climate between 4500 and 6500 feet is favourable, and here the rainfall is only 30 inches per annum, less than a third of that at Dharmsala on the outer slopes of the Dhaola Dhar. In March and April fruit blossom adorns the valley throughout its length and breadth. The fauna need not detain us, as it is much the same as in the adjoining hills. There is little detailed geological information available about Kulu, which is practically all slate, schist, and garnet. From above Bajaura we first see the snow cone of Gyephang in Lahul peeping over the Rohtang pass at the head of the Kulu valley, where the Beas has its traditional source. In its 40-mile course thence to Bajaura the river drops 9500 feet. In the first 10 miles the fall is 7000 feet, nearly three-quarters of the total drop. Bajaura is only 3600 feet high. Cultivation and human habitation extend to above 8000 feet. Till June the Rohtang, 13,000 feet high, is not clear of snow, the winter accumulations of which are 40 feet or more deep in late February.

Kulu People and Religion.—The agriculturists of Kulu are preponderatingly Kanets, who, according to the most recent authority, were in all probability among the earliest Aryan invaders of the Himalaya. Their religion is peculiarly local and entirely different from the Hinduism of the Punjab plains and even that of the Kangra hills. The gods own a large share of the cultivated land, and their worshippers are also their tenants. The village god is a popular local institution, managed by the Kanet village community in its own interest. It seems to be often a family deity in origin, though it is sometimes a nature spirit exercising sway over a larger but still limited tract of country. This local worship, despite seventeenth-century and other Brahministic importations of Rajput chiefs, is essentially democratic and non-Brahministic. The village gods are extremely human, easily offended, and most capricious. They have their divine or semi-divine relations and acquaintances, whom they entertain and visit on fixed

'At Home' days. Gods and worshippers keep in close communion through the agency of prophets, a remarkable and widespread class found throughout Kulu and the neighbouring hill states. These prophets, like those of the Old Testament, are selected by the deity to act as his human mouthpieces. In Kulu the deity may pick out a man of any caste, Kanet or menial Kohli, as his Gur or prophet. Indian Buddhism, prevalent in the seventh century and earlier, has disappeared and the old gods again hold sway.

The people are cheery and contented peasants, the spoilt children of a rich country that lavishly supplies all their simple wants. Their substantial stone timber-bonded houses of two or more stories are veritable palaces, compared to the mud houses of the Punjab and thatched huts of Bengal. The women can hold their own with any peasantry in the world in comeliness of feature and beauty of colouring, also in grace of dress, though their ideas of cleanliness and marital fidelity may be open to criticism. The Kulu people are aloof and suspicious of outsiders, but insist on discussing their most intimate family and religious affairs with their alien ruler, whom they expect to take, and who fortunately often does take, an interest in these matters. They are much attached to their mountain homes, and dislike even a journey to Dharmsala in the outer hills. Before 1915 they did not join the army, but of the small number that were induced to enlist in the war some served creditably in Mesopotamia, Syria, and Egypt. Their chief pleasures are dancing, drinking, and lovemaking, for indulgence in which pursuits the March to October season of religious fairs affords every facility.

The Kulu man's dress consists of a heavy woollen homespun coat-blouse reaching nearly to the knees, trousers tight at the ankles, a coarse shepherd's plaid, and a small round black cap. The women knot cotton handkerchiefs over their heads like Italian girls, and gracefully drape gay-bordered blankets around their persons as dresses, which they fasten together with large clasp pins. Their jewellery, mostly silver and enamel, is barbaric and effective.

Sultanpur, or Kulu town, the little trade centre of a country, the natives of which want little from shops and seldom care to make money, is 8 miles higher up than Bajaura. Fourteen miles further and 2000 feet higher lies Nagar, the old capital of the Kulu Rajas and now the headquarters of the Assistant Commissioner, Forest Officer, and Engineer. A few other Europeans, engaged in fruit culture, have residences here on the 6000-foot limit along deodar-clad slopes, 1500 feet above the left bank of the Beas. Halfway between Sultanpur and Nagar, the Beas is crossed at Raisan by a typical cantilever bridge of timber. This river, once the exclusive domain of the prolific and sharp-boned mountain barbel, has since 1910 been stocked with brown trout from Kashmir, which at an age of four or five years attain to a weight of six to eight pounds, but rarely take the fly.

Malana.—We shall not approach Spiti and Lahul by the usual Chandra valley routes over the Hamta and Rohtang passes. Instead, from Nagar let us turn up the mountain-side eastward and through deodar, spruce, and fir forests gain the Chandra Kanni pass, 3000 feet below which is situated Malana village. The deep and narrow Malana glen joins the Parbati valley, but so steep and rugged is the chasm through which the Malana river has cut its way out, that the easiest approach to the isolated village is over the mountains. Devta Jamlu, or Jang Jamlu, as the Malanis call him, resides on Indrasau, a 20,417-foot peak at the head of the glen on the Beas-Chenab divide. He is supreme lord of everything in Malana—of the people, animals, the land and its produce. The Malana people relate how he and his wife, Naroi, on their first entry into Malana, rested on the top of the Chandra Kanni. They opened a casket, whence the gods of Kulu emerged and were blown to their present abodes. The casket is still preserved at Malana! This legend symbolizes Jamlu's position compared to the Kulu village gods. He is throughout Kulu regarded as a mighty spirit of the mountains, feared by men and godlings alike. The latter often submit their disputes to his arbitration. His brother, Gyephang of the Lahul peak, and his sister, Hirma or Harimba, now of Manali, but formerly of the Rohtang ridge, share the respect in which Jamlu is held as one greater than local village devtas. Indeed, the proud Malanis boast that Jamlu once exerted his power over the Emperor Akbar in far-off Delhi, and inflicted leprosy upon him, because his tax-gatherers had unjustly extorted from a Sadhu on his entrance into Delhi two pice given to him from the Malana treasury. Even now, year by year in the spring at a spot called Karauni, they commemorate in mimicry the arrival of the embassy, bearing rich gifts, which Akbar sent in order to be freed of his leprosy. Jamlu has no image and no temple, but his spouse, Naroi, has a small shrine. The god does not express his will only through his prophets. Often the divine afflatus descends upon the Ra Deo, the whole assembled body of Jamlu's own people. In the spring the two priests hold solitary communion with Jamlu for several days in a small hut called "Pholobari" till barley seed taken by them inside has sprouted.

The Malana religious practices have been described, but little is on record about the highly democratic theocracy of this isolated village of less than 400 inhabitants. Malana, in fact, abounds with religious and social survivals, some probably dating from a time before the first Aryan wave of immigrants had entered Kulu. In Malana we have the general assembly, or Ra Deo, and an elected senate of eight elders, the Jathira. When even one of them dies, a new set of eight must be appointed. With the elders sit also the three principal officials, namely, (1) the hereditary manager and high priest, known as the Karmishta; (2) the god's own selected prophet, or Gur; and (3) the senior hereditary priest, or Pujari. In most matters of communal interest these two bodies sit

together in the place of assembly. The senate and officials are called collectively the Rigin Nashing, or upper assembly; they sit up above on the raised stone platform, with the Ra Deo in front below. All disputes between residents of Malana are settled by the elders. The only Malana cases that have come before me have been with outsiders. One was Devta Jamlu *versus* a British colonel. They are conducted by the Karmishta, no doubt under Jamlu's instructions. The manager, or Karmishta, is assisted or checked by two bodies, one a treasury committee of five and the other a storehouse committee of four Kothialis, who are appointed by the Ra Deo. Thus in almost every matter the Bari, or officials, are closely watched by the community. Shoi, the Karmishta, I knew well and respected greatly. Sixty-four years old and reserved, he combined business-like acumen and independence with charm of manner and undoubted sincerity, qualities rare in Kulu. In figure he was slight, his face was somewhat drawn and pointed, and his clear eyes had a far-away look, though bright and animated during conversation. When he first came to me he was clad all in black, which emphasized his singular personality.

The Malana language, Kanashi, intelligible only to inhabitants of this one village and different from Kului and Tibetan alike in structure, is of a family represented in a few other small groups of tongues found in Lahul, Bashahr, Almora, and Eastern Nepal, all spoken by hill tribes on the linguistic border-land between Tibetan and Indo-European speech. This has been pointed out by Sir George Grierson in his Linguistic Survey. Kanashi is unwritten and has tones like Central Tibetan and Burman. Dr. Francke thinks it has affinities with the earliest known group of Indian languages, such as the Munda, that belongs to the old Austric family, which is found from Sunday Island off South America to Madagascar and even as far as New Zealand. But in the Linguistic Survey Kanashi is described, not very succinctly, as a "Complex pronominalized Himalayan Tibeto-Burman Language." A few samples of the unusual Malana personal names may be of interest. Aïti, Gui, Buia, Muian, and Shoita are men's names. Women's are Aïa, Chakoti, and Sako. In addition there is also a remnant of what is, perhaps, another language, known as Naroi's speech, since it is used only in her worship. Songs in it are taught by mother-in-law to daughter-in-law. Jamlu owns lands outside Malana in numerous Kulu villages throughout the basin of the Beas—a trace of the time when his worship was general. The Malana folk in a body visit these villages every summer and billet themselves on the inhabitants, who fear the Malanis as weird and uncanny people in league with an all-powerful spirit it is unsafe to offend. Our boastful Malanis affect to despise the Kuluis as fools, who waste their substance on women, beer, and disputes, and contemptuously describe their gods' temples as Jamlu's outhouses. They do not intermarry with Kulu people, except that they take girls from Rashol, a hamlet just outside Malana.

They pride themselves on their peculiar customs and arrogate to themselves a wisdom superior to that of the rest of mankind. Perhaps their little Utopia is after all better off than many parts of our distracted outer world!

The Parbati Valley.—From the summit of the Roshkoling or Rashol pass we look down into the valley sacred to the goddess Parbati, the gentle daughter of Himalaya and bride of Mahadev. Before us is the barrier of the Great Himalayan range, over which our journey will take us. The Parbati has a course some 12 miles longer than the Beas, and probably carries more water at the junction by Bhuin, 3 miles above Bajaura. Both at Manikaran and Kheir Ganga in Kothi Kanaur, 22 and 40 miles above the confluence, occur groups of hot springs. Others are found in the upper Beas and the Sainj valleys. The hottest Manikaran spring reaches 201·2° F., and is used for cooking food. Others are utilized for thermal bathing establishments. The water issues from granite and contains carbonates of iron and lime, but no sulphur. The name "Mani Karan," or "Ear Ring," perpetuates the local legend of the origin of the springs. Once on a time Parbati placed her ear-rings on the bank before bathing in her stream. During her absence they were stolen by Sesha Nag, King of Lower Underworld. Evidently a suspicious character, he was soon taxed by the gods with the theft. So indignantly did he repudiate the charge that he gave a violent snort. Out of his nostrils came the stolen ear-rings, which his hot breath carried up through the earth and out at Manikaran. Hence the hot springs! Three miles above Manikaran we pass the abandoned Uchhieh silver-mines, for which the Rupi Waziri was once famed. Kulu is rich in silver, copper, lead, iron, and rough slate. Gold-dust is found in the Beas as well as in the Chenab, and tales are told of secret seams of copper and silver in the Malana valley. Twelve miles beyond Manikaran, Nakthan, the last Kulu village, is passed, and for eight days' march we shall see no human habitation. At Thakur Kua, 13 miles beyond Kheir Ganga, an elevation of 11,320 feet is attained. The Alpine flowers near here are marvellous; all arboreal growth, except stunted juniper scrub, has been left behind. Here we halted, sent back our surplus baggage and coolies, and collected a small amount of fuel for a week over bare stone, ice, and snow. Just before Thakur Kua the path is over a rock face, as the valley is contracted by spurs that close in to the river on either side. The monsoon almost exhausts itself just before this point, so the climate and vegetation now begin to resemble those beyond the central range in Spiti. In our next march we crossed to the right bank of the river by an enormous boulder, some 60 feet high, which bridges the stream. It is known as Pandoseo, the bridge of the Pandavas. Opposite it on the left bank is the last nala and glacier with a local name. This is the Dongspal, a name of Tibetan rather than Kulu sound. Perhaps it is a

relic of the days when the Tibetans held all the valleys which give access to Kulu from the east, and so controlled the old now disused trade route from the Shigri in the Chandra valley to Rampur. Henceforth the river runs near to us in a shallow spread-out stream or streams, instead of in a deep narrow gorge, as it did near Nakthan and Kheir Ganga. The valley, as we progress, curves gradually towards the south. Our camp at Roba Thach, at 12,700 feet, was on the alluvial flat of an old lake-bed. Below it we had toiled over masses of old moraine débris.

The Parbati Glacier.—Three miles above, an enormous moraine tumbled right across the main valley from the west; beyond this dam lay a shallow lake that was drained over the moraine barrier by a gap near the right bank. From an opening beneath the ice and débris issued water from the lateral glacial moraine. From below, this lateral moraine looked like the end of the main Parbati glacier, but the latter was another 1½ miles distant hence, at an elevation of 13,540 feet and 43 miles from our last camp in inhabited country at Pulga. The snout was that of a slowly receding glacier, but observation showed it to be, if anything, a little in advance of the position given it in the 1904 1-inch map, which up to this point was found to be tolerably accurate. This map is based on surveys made in 1894–5 and 1900–1. The surveyor seems to have penetrated only a short way behind here; hence his error in supposing the visible top of the glacier, 6 miles away, to be up against the actual Pin-Parbati watershed. The glacier, in fact, turned to the east, and so continued out of his sight in the shape of a wide icefield at a much higher level for more than 1½ miles further. Its total length is 7½ miles, the largest glacier in Kulu.

The afternoon was spent in endeavouring to fix the position of the glacier snout, a task interrupted by the appearance of some inquisitive burrhel (*Ovis nahura*) on the heights above, and lengthened by the extreme hardness of the rock in which we tried to hew marks. The thermometer fell to under 38° F. at night. Only above 15,000 feet does it fall below the freezing-point at night all the summer. On leaving our camp by a small torrent that rushed down the right bank, we scrambled along the eastern glacial stream for just over a mile of the roughest imaginable going. This took about two hours. Then we arrived at the spot where a considerable volume of water issued from two ice caves in cliffs of thick black ice, surmounted by gigantic piles of moraine débris, which filled the valley from side to side. These tumbled masses of débris, ice, and snow made us search for an easier route along the rocks, but precipices drove us back to the moraine.

We had with us a tent-pitcher, one Jaiwant, who had in 1906 accompanied a former Assistant Commissioner, Mr. F. Skemp, into the Parbati valley from Spiti. Despite the uninviting appearance of its head, he thought he recognized a side nala as the one he had then descended by.

But after two hours' exploration he returned and excitedly reported that the way was blocked by a sheer wall of ice, that looked like the end of the world, and, if he had ever been anywhere near here before, which he now doubted, everything looked absolutely different. Certainly it did, as Mr. Skemp had come over some two months later in the summer, when the ice and snow were considerably less. Owing to the slowness of our progress and this delay we covered only 2½ miles that day, and bivouacked on a little shelf 300 feet above the glacier at 14,850 feet. Our progress was slow, as we were a large party of nine, with fifty-two coolies and two headmen, and had with us almost two months' supplies. This year it was a scarcity of food, both for man and beast, that caused me to visit Spiti in order to organize relief measures. So the coolies had full loads and the pace was slow.

We went to rest looking out on to three magnificent lateral glaciers, deluded by the incomplete survey map into the expectation that before 10 a.m. next morning we should be over in Spiti after an easy 4 or 5 miles' walk. The largest glacier opposite us seemed to present a practicable route westward over into the Rakti nala at the head of the Sainj valley between mountain peaks we had previously seen from the other side. In the revised 4-miles-to-the-inch map published in 1916 the Sainj is wrongly drawn as rising in the Great Himalaya. This error is also copied in a 2-miles-to-the-inch Forest Department map published in 1919. In reality, the Sainj rises in the range to the west of the upper Parbati. While both these maps cut off the upper 11 or 12 miles of the Parbati, the 1-inch map contains everything except the great snowfield on the upper glacier, which is little over 1½ miles wide from east to west. The omitted area amounts to some 5 square miles. The 4-miles-to-the-inch Indian Atlas sheet places the trijunction of Kulu, Spiti, and Bashahr, which is just south of the pass, approximately 10′ too far west and 15′ too far south. In it the drawing of the entire Parbati and Pin valleys above Thakur Kua and Baldur, respectively, is fanciful. The Pin in Spiti is made 10 miles too long. No even approximately correct map of the upper Pin valley yet exists, though in 1884 Sir Louis Dane, the first to explore these two valleys and cross from Spiti to the Parbati, pointed out that the mapping of the upper Parbati was wrong.

From our bivouac we descended on to the moraine and, once we reached its central hump, had an easy 4¼ miles' gradual ascent, first for a short way on rock and ice, and then over snow nearly to the position assigned to the watershed in the 1-inch map. But here to the east we were confronted by a very much hummocked wall of black ice apparently 300 feet or more high. It was evident that at this point (15,700 feet) the glacier came tumbling down between the base of two mountains in a sort of gigantic cascade from a higher level to where we stood. Over the ice wall and far beyond to the east we could just see the summit of a lofty peak. Two of us ascended the rock face to the south of the ice-fall to

prospect, but failed to find there any practicable route for laden coolies. Then we climbed up to the peak above, 1500 or 1600 feet higher than the base of the ice-fall. From it we looked east on to an extensive glaring snowfield, which gently sloped up to a bold serrated ridge with a low gap in the centre. Beyond the ridge we saw some not much lower mountain ranges, that ran away from the main ridge into the distance. There could be no doubt that we had at last located the watershed, and the surmise that the distant ranges beyond were on either side of the upper Pin subsequently proved correct. Our point of vantage also enabled me to discover an extremely steep but apparently practicable back door ascent from the lower glacier to the upper snowfield round the north side of the mountain on which I stood. There only remained time that afternoon to lead the party 1½ miles back down the soft and now ominously cracking glacier and 400 feet up above its right or east bank by a steep nala. Then at 15,750 feet we bivouacked on narrow rocky ledges. The next morning, July 6, we first negotiated a rocky ascent precipitous in places, where the rope was used; then we descended along a narrow rocky ledge on to a small glacier. But before we crossed this ledge heavy monsoon clouds came sweeping up the Sainj valley from the west and snow began to fall. A halt was called and temporary shelters erected, but happily before 11 a.m. clear blue sky appeared in the west, so on we went down to the snow. Then we zigzagged up a narrow and very steep snow slope, that was banked between the ice at the top of the small glacier and the base of the mountain ascended by me on the previous afternoon. We now found ourselves at an elevation of 17,000 feet on a low rocky wall, which separated the minor glacier we had just ascended from the large snowfield I had prospected the day before. We were above the ice-wall that had stopped us the previous morning. By 3 p.m. we were halting at an elevation of about 17,200 feet in a rocky gap on the Pin-Parbati watershed, 40 or 50 feet above the snowfield we had come over for the last 1½ miles.

The Pin-Parbati Divide.—The scene that met our eyes was worthy of the Great Himalaya. The camera gives some suggestion only of the broad vista towards the south-east, but its record is more adequate than words could be. The imagination too could not fail to be impressed by the thought that the civilization before us was Tibetan for over 1200 miles up to the borders of China, and Hindu civilization and Aryan languages had been left behind. We had visited the birthplace of the goddess Parbati, daughter of Himalaya. The mountainous region in front was, in formation and origin, entirely different from the Himalayan zone that stretched from the Dhaola Dhar to the range on which we stood. Here in primæval times lay the vast ocean named the Tethys: in the sediments 20,000 feet deep of this zone is represented almost every marine deposit from the time of the earliest known appearance of anim a

KYI VILLAGE AND MONASTERY, LOOKING NORTH UP THE SPITI VALLEY

CONFLUENCE OF THE PIN AND SPITI RIVERS, FROM DANKHAR, SPITI

KYELANG, LAHUL, LOOKING DOWN THE BHAGA VALLEY

CONFLUENCE OF CHANDRA AND BHAGA RIVERS AT TANDI, IN LAHUL

life. We erected a cairn to commemorate the first crossing of the range at this place by an English lady, my wife, and the first ascent from the Kulu side by any European. My predecessors, Sir Louis Dane in 1884 and Mr. F. Skemp in 1906, had both crossed from the Spiti side later in the year, perhaps by somewhat different routes from that taken by us.

Pin Valley in Spiti.—We camped in Spiti on the right bank of the Pin 3 miles beyond the pass at 14,890 feet, after a troublesome descent in the late afternoon over a treacherous, much-crevassed glacier covered with soft snow. Opposite our camp a large glacier from the north-west joined the Pin. A late start was made next day, as our coolies were fatigued and some needed medical attention. We first forded a stream from the south-west, and then crossed to the left bank of the Pin by a snow-bridge. An easy march took us to a sheltered and grassy camping ground facing the nala, which joins the Pin at Baldur from the direction of the Han-la or Babeh Pass that leads over into the Sutlej valley. Here flocks of goats and sheep were grazing, and the Bashahri shepherds gave us plenty of welcome milk. At Baldur are some remains known as Lyungti Khar, or Kulu forts, erected by a Kulu invader, perhaps Raja Man Singh or Jagat Singh. From here our Kulu men returned, and after a halt our baggage was carried to Muth, 11 miles distant, on yaks, which we had sent for. On this march we had a number of deep streams to cross. We were impressed by the excellence of the grazing and by the abundance of wild willow and other growth. Wild rhubarb and onions were plentiful, and were appreciated by us. The rainfall appears to be greater here than in the main Spiti valley. Muth, the first Spiti village with the exception of a few houses at Shian on the right bank 3 miles back, was a prosperous-looking hamlet of flat-roofed houses of Tibetan type, with fields green with young barley. The banks between the fields were ablaze with the large flower of the opaque light bluebell, which all the inhabitants seemed to be chewing. A broken-down rope bridge spanned the river. The next day brought us to Sangnam, the largest Pin village at the junction of the Parachu river with the Pin. At this camp the local demon showed his annoyance at our intrusion by a whirlwind that upset the tents, buried their occupants, and sent a heavy bread tin, saucepan lid, and tarpaulin flying high in the air for nearly one-third of a mile. The lid went into the river. I suppose the demon was satisfied with his spoils and his handiwork, as he did not trouble us again; but the villagers did, as that evening they came and danced and sang for hours before our tent.

The whole of the Pin valley above here is remarkable on account of the brightly coloured strata of the hillsides, and the sharp-pointed peaks that in July carry little snow under 18,000 feet. Its general aspect is quite unlike that of the main Spiti valley, which is more enclosed, so that few peaks and practically no snow is visible. Here the conglomerate formations, so frequent and striking at Dankhar and above, are absent.

Spiti is a perfect geological museum, as numerous series of strata are exposed to the view, and there is practically no covering of vegetation as in Kulu. Though there exist no accurate large-scale topographical maps like those made in Kulu for forest purposes, many parts of Spiti have been closely examined by geologists, especially by Sir Henry Hayden, to whose memoir of 1904 reference can be made by those interested. Red hæmatite and galena are found in small quantities. From the latter bullets are made locally. Gypsum occurs in very large quantities: it is extensively used as a plaster and wash for houses and temples outside and in. It forms an excellent base for frescoes and other paintings.

After Sangnam the Pin runs in a gorge for 8 miles. The view of its mouth from Dankhar Fort is remarkable. Above the right bank, where the river narrows, we pass the Pin monastery by a large poplar tree, said to have been planted at the foundation of the monastery, some eight or nine hundred years ago. Here only in Spiti is found the Nying-ma sect of monks, an early sect prior to the seventeenth-century reformation of Tsong-kapa and his disciples. That reformation has not affected this valley or Lahul, where also some traces of ancient Buddhism are preserved. In addition we have here in Pin an unique and curious set of friars or strolling players, called "Buzhen" (prounced Budjen). Sir James Lyall first described this order, which was founded by one Thang-Tsong Gyalpo, an incarnation of the God of Mercy, Chen-rezig, in order to win people to The Way of Buddha. Their performance consists of a medley of prayer, song, miracle play, and stone-breaking feats. Behind they set up a brightly painted wood altar with its usual appurtenances of images, bells, and offering vessels. Above it is a painting of their founder. Their hair is long and plaited into ropes. They cover their heads for the performance with long streamers of bright ribbon, and they wear pleated skirts also decked with numerous streamers. The rapidity of their gyrations, with their hair, ribbons, and skirts all flying out, resembles that of dancing Dervishes, and the brilliance of their colours, those of Russian dancers. Their jests we fortunately could not follow, as they were certainly not over-refined. They threw the audience, including old gentlemen piously engaged in whirling their prayer-wheels, into convulsions. There are only nineteen families of these Buzhens, who marry like the Nying-ma monks.

Spiti Valley.—There is no time to describe the main Spiti valley in detail. The river within Spiti is 70 miles in length. The total area of Spiti has been calculated to measure 2931 square miles, but only 2372 acres, all irrigated, are under cultivation. The population in 1911 was 3629, and entirely Tibetan. The name Spiti, pronounced there and in Tibet as Piti, means the "Middle Country," perhaps from its situation between Great Tibet and Little or Western Tibet. The language is that of Central Tibet, but it has a few resemblances to the Tibetan of Lahul.

Its lamaism, that weird medley of Buddhism, Tantric doctrine, and demon worship, hardly differs from that of Tibet, except perhaps in the identity of the demons, which seem in Spiti to be more numerous than the men. The dress is Tibetan; so are many of the customs, such as the salutation of the great by extending the tongue as far out as possible and keeping it there.

The villages are situated at elevations varying from 11,000 to just over 14,000 feet. Except at the bottom of the valley, there are no real trees. Near Mani, Lari, Tabo, and Pog we find poplars of fair size and juniper trees. Tabo even boasts one apricot tree. Barley forms three-quarters of the total crops. "Sermo," with its large grains in tiers of four in the ear instead of three, the dark beardless "Nyiu," and "Sowa," which is much like the common Kulu barley, are the three main varieties, but the quality is inferior to that of the similar kinds of barley in Lahul. Wheat, peas, oilseed, and small quantities of buckwheat and millet are also grown. The local seed measure is the khal, or sheep-load, instead of the bhar or man's load of Kulu. The khal is divided into 20 dre; a khal of barley is about 20 lbs., but one of wheat is 4 lbs. more. The domesticated animals are the yak, the famous surefooted Spiti ponies, a stalwart breed of small asses, sheep, and goats. The latter are few in number, under 6000 in all, unlike the vast flocks kept by the neighbouring Kuluis, Lahulas, Kuna-waris, and Rupshu nomads, some of whose animals annually visit Spiti for the summer grazing. Few animals die without being turned into food. The Spitials are great meat eaters; four or five men can finish a small sheep at a sitting after roasting it whole.

Spiti Customs and Government.—In striking contrast to Lahul and Kulu, where all sons share alike, there exists in Spiti a system of primogeniture that serves to maintain the holding of the family intact and to give the vigorous young and middle-aged people the main responsibility for its cultivation. The young do not have to wait for their parents' decease to enter upon their heritage. As soon the elder son grows up and marries, the ancestral house and fields are his. The parents are relegated to a small house with a field sufficient for their wants. The aged are happy cheery people and are apparently quite contented, even when the marriage of their grandson entails a removal to a still smaller house than before. These democratic people settle their own disputes in the village assembly, in which the women also assert their views: they elect their own village Gadpos, or Elders. The Gadpos Chenmos, or circle headmen for the five groups of villages, are elected and dismissed by the land-owners. These five men form the council of the hereditary Wazir, or Nono (noble). The custom, which over seventy years of nominal British rule has failed to end, that parties to suits before the court of the Nono and his councillors must supply them with beer till the case before them is decided, often leads to most protracted proceedings. Indeed, unless

the Assistant Commissioner of Kulu visited Spiti every two or three years, probably few cases would ever terminate before the decease of the parties. Fortunately, crime hardly exists and civil disputes are usually settled in the villages. Spiti does not labour under a cumbrous system of dyarchy or multiplicity of laws. It has been excluded from the operation of the recent "reforms," which are not needed in a country where flourishes a healthy democratic spirit of which there are few signs in India proper. Spiti is never likely to "go dry." Though salted greasy tea is universally drunk, barley beer, which gives the main reason why so much barley is grown, and which is consumed in vast quantities by clergy and laity alike, shows no signs of declining popularity.

The problem of what to do with the younger son is solved by sending him to the local monastery, where he will enter upon his monastic career as the servant and pupil in the family cell of, perhaps, his uncle. Both are maintained on the produce of a field, known as the "da-zhing," which forms a portion of the family holding. When the neophyte, known as "tsun-pa" or "get-sul," has passed his examinations, he becomes a full lama or "gelong." But even then, if his elder brother dies, he may, on payment of a fine, leave the monastery and succeed to the family estate and his brother's widow.

Monasteries.—The monasteries, as elsewhere in Tibet, are found in most picturesque situations. That at Dankhar is perched on a conglomerate pinnacle above the town, the large Kyi establishment surrounds the whole of a pyramidical hill, Than-gyud, just above the junction of two deep ravines, peeps 2000 feet down into the valley below, and to the east faces the holy twin-peaked Jo Jo Gang Milta, 23,050 feet high; Than-gyud's other name of Sakya Gongmig appropriately means the Upper Eye of the Sakya sect. Tabo alone is on a plain. Than-gyud, when on another more accessible site, was burnt down by the Tso-po, Galdan Chang's Mongols, three centuries ago, and Kyi, too, was fired by the Muhammadan inconoclast, Ghulam Khan, during the Dogra invasion. Fortunately Tabo, the most ancient and interesting monastery or rather temple of all, has escaped any such disaster. So far the legend that until the Yang-tso, or Mani lake, should dry up, so long would the temple remain, has proved true. The main hall, with a large four-headed image of Nam-par-nang-zad (Vairochana in Sanscrit), an early Buddha, and with thirty-two almost life-sized images of gods and goddesses seated on brackets round the walls, possesses the most impressive interior in Spiti. So far these thirty-two figures have not been identified, but Dr. Francke, the Moravian missionary, has recently informed me that they may be the gods of the pre-Buddhist Bon-pa religion, of which there are frequent traces in the neighbourhood. The frescoes more closely resemble those of Khotan and early India than those found elsewhere in Tibetan temples. Some probably date back to the tenth or eleventh centuries. Inscriptions show

that, as a Buddhist foundation, Tabo has existed from 1004 A.D. There are in all seven temples. The monks here are now of the reformed Gelugpa sect, as they are also at Kyi and Dankhar. Tabo, like some of the Lahul temples, certainly dates from the days when Buddhism was disappearing from India.

Dankhar and the Parang-la.—Dankhar, the capital village of Spiti, is perched up on the conglomerate pinnacles of a spur over the right bank of the Spiti river. To-day its appearance is almost the same as it was in 1820, when visited by Trebeck from Leh, where he had gone with Moorcroft, the first English visitor to Kulu and Lahul. Trebeck has left an interesting drawing of the village. Dankhar, 12,774 feet high, means the "Cold Fort." At one of our four visits here we stayed in the fort, whence we had an excellent view of the roof-life in the village under us. It is the official seat of the Wazir or Nono who resides at Koling, higher up the valley. There is not a single shop at Dankhar or elsewhere in Spiti!

I wished to travel from Spiti to the extreme north of Lahul in order to inspect the Leh–Kulu trade route from Lingti to Kulu, and also to see some of the work done to improve the approach to the Parang-la in the Sangba Lungba, a difficult river valley, by a man of Kyibar, whom I had persuaded to apply himself to this task. He had left the Thangyud monastery in an irregular manner on account of a love-affair, and had been sentenced by the monastic disciplinary court to expiate this breach of the rules by useful and arduous works, so I found him one beneficial to travellers and difficult enough to satisfy even the monks. Both he and his son, Chepa, were painters and copied several frescoes for me.

So it was that my wife and I crossed the Zangskar or Paralasa range by the Parang-la (18,300 feet), and back by the Pang-po-la (nearly 18,000 feet), which have been crossed by few Europeans and have not been accurately surveyed. The Indian Survey Department has no information as to the height of the latter pass, and has only an entry in a route map as to the height of the Parang-la, which coincided with my aneroid barometer reading. Trebeck in 1820 and Jäschke more recently considered it to be 19,000 feet high. Cunningham gives 18,502 feet, and the 1917 *Gazetteer* quotes this height.

We were able on our journey to follow the upper Parachu, a tributary of the Spiti, which joins it in Tibet; to see Tso Morari, the beautiful 16-mile long sapphire-blue Rupshu lake; and to visit the upper valley of the Tsarap river, which under the name of the Zangskar river joins the Indus below Leh.

Tso Morari, Rupshu.—The knot of mountains we visited drained into the Chenab, Indus, and Sutlej, as well as into Tso Morari, which I think may possibly have a subterranean connection with the Parachu, though there is now no surface channel. The water of this enclosed lake is only

very slightly brackish, which is surprising if evaporation is the only factor in removing the equivalent of the considerable volume of water added to it by its feeder streams in summer and by melting snow in spring. From the south shore of the lake, the gravelly plain gently slopes upwards for 3 miles. Down it the Phirsi Fu stream ripples north in a shallow bed. Almost in a line with the exit of this stream from the hills to the west into the plain is the present surface watershed between the lake and the Parachu, the main stream of which is $5\frac{1}{2}$ miles to the south at Norbu Sumdo. When I stood on the hillside above this watershed, and looked first towards the lake and then towards Norbu Sumdo, there seemed to be no very marked difference of slope in either direction. As Norbu Sumdo is further off and the river channel is under high banks, I formed the impression that the river level there was just a little lower than the present lake surface, and that the watershed was not more than 100 or 150 feet above the lake. My Ross Compensated Watkin Barometer, which could not, of course, be entirely trusted for these small differences of level, indicated Tso Morari as being just above 15,200 feet, and Norbu Sumdo as about 100 feet less. I was unaware at the time that Cunningham thought the watershed to be 700 feet higher than the lake, and that sheet No. 52 of the "India and Adjacent Countries" map showed the heights of Karzok by Tso Morari and Norbu Sumdo as 14,900 feet and 15,300 feet. On these heights I presume Mr. Oldham based his theory of an elevation of the Parachu's bed.

Till accurate levelling is done, it will not be possible to arrive at any conclusive results as to whether Tso Morari has subterranean drainage towards the Parachu. It is unsafe to build hypotheses on heights which are either unreliable or the exact positions of which do not appear from the map. Possibly neither of the two heights in question was taken at the water-level.

Three facts, however, deserve attention: (1) The old terraces above the lake show that formerly the water-level reached more than 200 or 300 feet above the present surface, so that at one time the south shore was much further south. (2) The lake is not becoming more saline, though there is no surface drainage; in 1820 Trebeck found it brackish. And (3) about 2 miles to the south of the watershed near Shialli Chumik the middle of the plain is very swampy, apparently owing to percolation from below, and from it a large volume of water drains into the Para river.

Captain A. Gerard's information of 1817–18 that the Para river issued from the lake may be based on a tradition of an early surface outlet. Moorcroft's map, which is compiled from material collected in 1820, indicates the Phirsi Fu as running into a stream or streams, continuous thence both to the lake and to the Parachu. In 1846, as appears from a letter at Nagar, Cunningham was told that the Phirsi Fu, which then flowed north as now, sometimes flowed south also; he considered

that the lake originally emptied into the Parachu. Undoubtedly, even after the lake had receded as a result of desiccation and evaporation, the Phirsi Fu has continued to raise its bed, which formed the watershed between the lake and river. For the last eighty or a hundred years the stream has more or less settled down to flow north only. Probably the lake originally lost its surface outlet to the Parachu as the combined result of the fall of the lake level and the rise of the mass of detritus brought down by the Phirsi Fu.

At Shialli Chumik, close to the Spiti boundary with Rupshu, we were met by the Gova, or chief of the nomad Chang-pas, who graze their long-fleeced Biangi sheep in pastures 15,000 to 17,000 feet high, and whose great yaks are without the nose-ring, that last vestige of civilization found on Spiti and most other domestic yaks. A little barley is grown at Karzok, 15,000 feet high, where there is a monastery, and the Gova has the one house in the country. The wide plains near Tso Morari teemed with animal life. The kiang (*Equus hemionus*) roamed about in pairs and in herds, often within 100 yards of our ponies. The large hare and great marmot were numerous. The soil was undermined by rats. Geese were nesting, and hundreds of sand-grouse settled down to the south of the lake. The Nahu, or Burrhel (*Ovis nahura*), was as common as in Spiti, and the horns of the Nyan (*Ovis Hodgsoni*) were frequently met with. Though brackish, Tso Morari contained no fish; the streams and lagoons by the lake abounded with small fry.

Pang-po-la to Lingti.—The ascent to the Pang-po-la (under 18,000 feet) from the east was easy, unlike the east side of the Parang, which was covered with hummocked and crevassed soft snow. The crest of the Pang-po (meaning "the green turf summit") was free from snow and grass-covered, as its name indicates; but the descent towards the Tsarap proved to be the steepest bit of screes I had ever been over. The animals put their legs together, sat down, and somehow slid to the bottom safely, and we did much the same. The ascent to the Parang from the west had been trying, but this abrupt descent was infinitely worse. After two camps on the Tsarap we reached Lingti plain. It took us a hard five hours' work, at a place where the conglomerate cliffs dipped sheer into the stream, to hew a path practicable for unladen beasts. Our last march was as much in the river as on land. We had to walk the whole way, as the unshod feet of our ponies had suffered from the long stony marches and the trying slide down from the Pang-po. Owing to the rising river and delay in making the path along the cliffs, our baggage yaks reached Sarchu on Lingti after midnight. Our joy at their arrival was diminished when we found tent and blankets to be dripping with water. The large furze-covered Lingti plain, 14,650 feet high, is well known, as it is on the Kulu–Leh road. Here we parted with our Rupshu nomads, and in two days crossed the Baralacha to Patseo, or Dozang, 36 miles distant.

The Chandra Bhaga River and the Shigri Moraine.—On the Baralacha (16,047 feet) in Lahul rise the Yunan river, which joins the Tsarap, and the two headstreams of the Chenab, which meet at Tandi (9500 feet). From the pass to that point the Bhaga has a fairly direct course of 60 miles, but the Chandra makes a southerly détour round by the Shigri glacier and covers 115 miles.

The inhabited part of Lahul is on the lower 30 miles of these two streams and along the Chandra Bhaga for 15 miles below the junction.

A brief mention of the great Shigri glacier, which has to be crossed on the usual route from Kulu to Spiti over the Hamta and Kunzam passes, may be of interest. It has been surveyed and described by Messrs. Walker and Pascoe of the Geological Survey. It rises near the point where the Pir Panjal branches off from the Great Himalaya. Two striking twin peaks over 21,000 feet high rise behind it. They are known as the Peaks of Good and Evil (*i.e.* Dharmsura and Papsura), and are said to vary in height according as Good or Evil prevails in the world. Of course, now the last-named peak is much the higher. To the south they look down the Tos nala, the mouth of which we passed near Nakthan in the Parbati valley. The length of the Shigri is about 15 miles, and its greatest breadth over a mile. In 1869 Harcourt paced it as 2 miles, but pacing is quite inaccurate amid the hillocks of such a moraine. In 1873 it took the traveller, A. Wilson, author of 'The Abode of Snow,' three hours to cross, and our passages occupied well over two hours. In the mountain to its left are veins of stibnite. The masses of moraine matter on the Shigri were aptly described by Wilson as like the huge ridges of a fallen mountain. Immense boulders and smaller débris are constantly hurtling down the slopes on to the moraine. Two marches lower down the Chandra valley we ourselves once witnessed from close quarters the discharge of hundreds of tons of granite, that formed a part of the summit of a mountain 7000 feet above the river. The whole north portion of the peak split off with a loud cracking, followed by a thunderous roar and thick clouds of dust. Immense stone blocks 30 or 40 feet high came bounding down the slopes and jumped far over the river, here 100 feet in width. The mountains have far from settled down, and the combined effects of alternate intense dry heat and bitter cold are constantly operating to break them up and to fill the moraines and river valleys with their débris. During May in the Chandra valley, from 10 a.m. till late afternoon, avalanches seem never to cease crashing.

Patseo Trade Fair.—But we must return to Patseo, a place on the Bhaga below the Baralacha and 8 miles above the first Lahul village, Darcha, where every August Lahulas, Kuluis, Tibetans, and Chang-pas gather to sell or barter wool, salt, borax, and other products. A little wool is brought here on pack sheep and goats, but immense Biangi flocks are themselves driven down by the Chang-pas and shorn by the Lahula

buyers and their men. These fine sheep are soon hurried away, as they cannot for long endure the low altitude of only 12,925 feet. Patseo is a most busy place for three or four weeks every year. The little stony plains on both sides of the narrow river, here once crossed by a stone bridge, and hence called Patseo by Kuluis and Do-zang by Tibetans (from pat and do, meaning "stone," and seo and zampa, meaning "bridge"), are covered with little tents. Each set of people keeps to its own tent-pitch and uses the same piled stone enclosure to keep the wind off. Besides regular traders—the Lahulas buy or rather pay an advance on the wool the year before, and also own several of the Tibetan flocks—casual buyers from Lahul and Kulu attend; and the smiling Khampa wanderers, who once lived on the confines of China and still keep up the dress of the East, foregather and engage in peddling all sorts of worthless trinkets from the plains. In winter they descend as far as Hoshiarpur and Pathankot, whence some take train to Delhi and even Calcutta. At Patseo, too, we find a few tall picturesque Gaddis with their flocks, which in summer graze on the south-westerly slopes of the Baralacha, and in winter are taken to the lower Kangra hills between the Dhaola Dhar and Outer Siwaliks. The Gaddi's own home is under Kailas in Brahmaur. In August the trade fair is attended by a diversity of hill peoples, but in September Patseo is populated only by large herds of ibex, which come to lick the stones where the Tibetan salt has been piled.

The trade imports into Lahul and Kulu from Central Asia are, if we take into account the communications and means of transport, fairly considerable. In the one year 1918–19, the main imports (in maunds of 80 pounds and valued in rupees) were as follows: Wool, 3878 maunds, worth Rs.1,49,907; salt, 5820 maunds, worth Rs.11,640; and borax, 240 maunds, worth Rs.1200—all brought in on pack sheep and goats: 9050 of these animals were imported in 1917–18, many to go to butchers.

The exports from the Punjab *viâ* Lahul are somewhat insignificant. Only cotton piece goods have any considerable value, *i.e.* Rs.24,898. In 1918–19 silver to the value of Rs.99,893 in coin left Lahul; in all Rs.3,06,689 worth of silver went into Central Asia and Tibet from the Punjab to make up the adverse trade balance in that year. Since 1903 the price of the long-staple Biangi wool more than doubled. A quantity of pashm or fine shawl wool, the downy under-fleece of the goat and other animals that live at great heights, is included among the wool imports. It is remarkable that a large quantity of inferior brick tea from China reaches Spiti and Lahul overland, though these countries are situated politically in a Punjab tea-growing district. In 1918–19 only 312 maunds of Kangra and Kulu tea passed the Lahul Trade Post. A constant stream of grain goes up from Lahul and Kulu to Rupshu and beyond as these countries produce insufficient crops for the support of their inhabitants.

Lahul.—Lahul and Spiti are often mentioned together as if they were much alike; but, at least as regards the inhabited parts, the resemblance is less marked than the difference. Spiti is isolated, and the population is almost stationary on account of the social customs. Spiti people are intensely conservative and stay-at-home. Lahul lies between the three countries of Ladakh, Chamba, and Kulu, which in old days were constantly invading each other through Lahul. It is on the Central Asian trade route from the east Punjab to Leh and Yarkand. The Lahulas are enterprising traders, who wander far afield. They are constantly increasing in numbers, as even their lamas, of the Drugpa sect, marry. Whereas Spiti is uniformly Tibetan in language and civilization, Lahul with a smaller area of 1764 square miles has a population of the most diverse elements and four different languages. In 1911 the population amounted to 7760.

Except in the upper Bhaga and Chandra valleys, where a Tibetan which is midway between that of Spiti and the toneless West-Tibetan dialect of Ladakh is spoken, the three local languages belong to a group quite different from Central Tibetan or Ladakhi. The social and monastic systems have little in common with those of Spiti. In Lahul polyandry is practised, as it is also in Saraj in Kulu, and so a man often finds it impossible to name his father. Primogeniture only prevails in the Thakur or "Jo" noble families, which have a Tibetan origin. The lamas have less power here, and, owing to their not being celibate, are not as sharply cut off from the laymen as in Spiti. There are communities of nuns, a profession always open to the unmarried ugly daughter. Boys and girls alike are taught Tibetan at the monasteries, so the degree of literacy is higher than in Kulu and most of India.

In the Mauchat towards Chamba, Hinduism and ideas of caste have crept in during recent years. The dress is only Tibetan in the higher villages. Elsewhere the men's dress approximates to that of Kulu, but the women's is peculiar to Lahul. It is like a long dressing-gown, girded by a cord. The head is bare, except for a silver lotus-shaped cup from which large round silver earrings are suspended.

The Tantric Buddhism, that Padma Sambhava introduced into Lahul and Tibet in the eighth century, has survived here with less change than it has suffered further east. Lahul, probably owing to its distance and political separation from Great Tibet, was little affected by the monastic reformations of the fifteenth and sixteenth centuries that considerably modified the early Buddhism of Tibet and the main valley of Spiti.

Many of the temples, including the important one of Guru Ghantal or Dil-buri, still preserve the old wood pent-roof form, which is never found in Spiti, but is common in Kulu and Chamba. The proximity of timber, has, of course, something to do with this, but the houses of the laity in Lahul are flat-roofed and remind us of Spiti rather than Kulu architecture. Some of the religious frescoes are of early style, and the

white marble head of the Boddhisatva Avalokiteshwara in one temple is distinctly Buddhist Indian work.

Though Lahul is somewhat lower than Spiti in the inhabited parts, which lie between 9000 and 12,000 feet, the amount of snow-fall is almost four times that of Spiti; 7 or 8 feet often collects at Kyelang. There is also slightly more rain. Water is plentiful, and both trees and crops flourish. Below 12,000 feet the shupka, or pencil cedar, the kail or blue pine, and the bhurj or birch grow in thick forests and relieve the monotony of the bare hillsides. Near villages lines of pollarded willows follow the water-channels, and both the Himalayan and Lombardy poplar (*Populus ciliata* and *nigra*) are planted. The crops resemble those of Spiti, but more buckwheat is produced. The Lahul barley is famed for its excellent quality and is more valued than wheat. The parched barley meal or "tsampa" is delicious and satisfying. In the lower parts of the country two successive crops of barley and buckwheat are obtained. Grass and Ladakh lucerne are grown in irrigated fields for winter fodder for the ponies, cattle, and flocks. Apples, pears, and apricots do well, but ripen late. A feature of Lahul is the number of rose bushes, many of which bear large blooms of a distinctive yellow shade. A botanist has enumerated 282 different varieties of Lahul roses.

The alpine grazing of Lahul is unsurpassed. Foreign sheep and goats to the number of 168,000 have come over the passes in one summer to fatten on the succulent blue grass, or "niru." The Lahulas themselves keep large flocks, also herds of ponies and hybrid yaks, known as "churu" locally and "zho" in Tibetan. The churu cows give fine rich milk, greater in quantity than the pure yak cows give. Yak bulls are kept only as stallions.

Like Spiti the country is directly governed by a hereditary Wazir. He is of the Kolong noble family, which has always displayed the most active loyalty to the British Government. The late Wazir, Thakur Amar Chand, personally took over a hundred of his men to Mesopotamia early in the war. His father, Thakur Hari Chand, travelled extensively in Tibet and Turkestan for the Government, and administered his country with conspicuous success. Thakur Amar Chand's brother has recently been put in charge of the Lahul roads and forests. No Indian officials are employed either in Lahul or Spiti, except on occasional inspection duty. Kyelang, the capital of Lahul (10,100 feet), commands extensive distant views of majestic mountains both up and down the Bhaga valley. The foreground includes many hamlets and sinuous lines of bright green willows and well-watered fields of luxuriant crops. There are flowers everywhere.

The climate is dry and invigorating. "Kyelang under the snows" has a quiet beauty and charm all its own, which the traveller appreciates equally, whether he has come up from the damp oppressive heat of a

Kulu summer or down from the arid wind-swept wastes beyond the Great Himalaya.

Before the paper the PRESIDENT said: I hope you will all congratulate the management of the Society upon the appropriateness of the lectures which it provides. Some few weeks ago, when there was a most awful blizzard, you were provided with a lecture on Mesopotamia. In the heat of the evening of what I understand has been the hottest day of the present year, with the thermometer at 86°, we are provided with a lecture upon the Himalaya and the snowy passes of Kulu and Lahul. Mr. Shuttleworth was the District Officer in charge of Kulu, one of the most delightful spots in the British Empire, and very much like Kashmir in miniature; he was monarch of all he surveyed in that district. I have much pleasure in asking him to give us his paper.

Mr. H. Lee Shuttleworth then read the paper printed above, and a discussion followed.

The PRESIDENT: Thirty-eight years ago I made my first trip in the Himalayas into this very country of Kulu, and there I was most hospitably entertained by Sir Louis Dane, that versatile genius who was not only Foreign Secretary in India and a great diplomatist, but also Governor of the Punjab. He made his mark in the Punjab as an engineer, and to-night he will appear to us as the explorer of the pass between Spiti and Kulu. I ask Sir Louis Dane to speak.

Sir LOUIS DANE: I first went to Kulu in 1880, a very long time ago, and when I married in 1882 I took my wife there, and we spent a honeymoon of three years in Kulu. She was a much better mountaineer than I was, and she went everywhere with me until there was a baby, and the doctor would not allow the baby to go over passes of 16,000 feet. The baby, I may say, often travelled strapped on the back of a woman or a man, as the case might be, as the by-roads were impassable for any other form of conveyance. I had the time of my life in making roads and making the place passable for four-footed animals. Up to that time the only form of carriage in Kulu, apart from the Central Asian trade route, until you got into Tibet, was laden coolies, and you had to keep gangs of them halted at different stages on the chance of a passenger passing through. Before I left India I resolved to do something for my first and last love, Kulu. We made a better graded road for the fruit and general traffic into Simla, and started the road up the valley of the Beas which you saw in the photographs, and which goes up an even gradient the whole way. If I were in India I should drive into Kulu in a motor-car by the year after next.

I was very lucky when I went to Kulu, because nobody had been there for eighteen months, and things had got rather out of hand. A big mine of sapphires had been found. I dare say you have all heard of the Kulu sapphires; they are supposed to be the finest there are, and they are found on the borders of Kashmir and Chamba at a place called Zangskar. A shepherd had lost the flint of his flint-and-steel; he was hunting about for another and found a blue stone. He struck it and found it gave very excellent sparks. He brought down a pocketful of blue stones, and later a man came down into Kulu with a donkey-load of blue stones that he was offering to exchange with anybody for a donkey-load of flour. One European who had been a Forest Officer was offered them, and he said he thought it was all nonsense and did not buy them. They got to Delhi, however, and all Delhi went up there, and there

were all sorts of complications. I might have made my fortune, because after I went up the Delhi jewellers had given out that the sapphires were not real but something else. I happened to know enough about minerals to know that they were sapphires, and if it had not been for the ridiculous proscriptions of the Government, which prevented one from engaging in legitimate trade, I might stand before you to-night as a millionaire instead of being a poor pensioned Civil Servant.

I am sorry that the old castle of Nagar has been given up as a residence and is only used as a court and office. It was supposed to be haunted. A fair Ranee had been accused of infidelity to her husband and was hurled from the battlements. However, her innocence was afterwards proved and she haunted the premises. My wife and I slept in the haunted room and we were never incommoded. But the chaplain from Dharmsala, who used to come and see us once in three years or so, had a very bad night, and I believe that some of my successors were more psychic than we were and they also were disturbed. However, I have no doubt that my relationship with Jhemlu saved me from such minor inconveniences. In fact, I found that relationship with Jhemlu had most excellent results. Whenever I gave an order it was never questioned. Jhemlu's headmen used to come down in the winter and sit for a fortnight in my verandah, and I used to feed them largely and nobly in recognition of our kinship.

You have heard of the Kulu fruit. Peaches, apricots, and apples are all excellent, but the pears are superb. The first growers intended to dry the fruits, but it was clear that America could send a ton for every pound Kulu could put out. My wife and I took in two coolie-loads of apples and pears and asked an enterprising merchant in Simla if he could sell them. He ate one pear and said, "I could sell as much as you can send." We paid Rs.40 a maund (82 lbs.) for pears, and something less for apples. Lord William Beresford happened to pass the shop, ate a pear, and bought the lot. For two years we arranged a coolie *dak* or service of runners for the fruit, and that is how the Kulu fruit trade was started. To get the Kulu people to grow the fruit we taught the Nagar schoolmaster grafting and budding, and he did very well out of it. Later on as Lieut.-Governor I induced the Conservator of Forests to make his men more popular by teaching the natives through them generally something about fruits. I hope that success has attended their labours, but in these hill tracts everything depends on the human agency, and votes and resolutions of Government are useless. The peaches and apricots ripen in the very hot weather at the beginning of the rains, and so far it has not been possible to get them to market in good condition owing to the journey.

Trout is an old story. By changing the position of the hatchery, with the continued assistance of the Duke of Bedford, at long last we succeeded in getting trout to breed in Kashmir through Mr. Frank Mitchell, who was actually in charge of the matter. After six years they sent me from the hatchery a fish weighing 18½ lbs., which is a good size for a brown trout. From Kashmir we got the ova and spread trout through the Panjab hills.

As regards the Pin–Parbati route, which is my only claim to be called a geographer, I was fortunate there. I was young, and I had not much regard for the consequences, and I came down the hill instead of going up as Mr. Shuttleworth did. I think any one who has been over a mountain pass wil know it is one thing to start at 11,000 feet from your camp and go over a pass 17,500 feet and another to start 16,000 feet, as I did, walk quietly in the early morning to the top of the pass, and then saunter down the glacier in the course

of the day. I admit it took me from four o'clock in the morning to six o'clock in the evening, and it was a purely unscientific proceeding. I wanted to save eighteen marches, and did not want to go back by the way I had come. We, however, had great difficulty with the people. They all tried to bolt over the Bhabeh Pass, but I was too quick for them there. I rode on in front and cut them off. Then when we got to the top of this pass we found a very unpromising look-out. I put the pass at about 17,500 feet high. It was about 2 miles across that upper Parbati glacier or icefield, and there was no apparent outlet. The coolies all threw down their loads; even my yaks looked suspicious; in fact, the only animal that was unperturbed was my pony, which proceeded to walk down the other side as though he knew all about it. I pulled out an old survey map, which I quite agree with Mr. Shuttleworth was quite incorrect at this point. I had a sundial compass and a pair of binoculars. Those were the scientific appliances which this first discoverer of the Pin–Parbati Pass employed. I looked at the sun and at the map and said, "This is the road," and I did so because it was the only possible way we could get off where we were standing. Where we were to go afterwards we could not tell. But we got along quite well.

It is a great place for pilgrimage; they come even from Madras to see the hot springs at Manikaran, and some go up to the source of the Parbati, though a great many of them never return. When you see the pictures you can understand that a man from Southern India getting into one of these glaciers is likely to die there from cold or to be caught in a snowstorm. There was a proverb in Kulu that nobody ever saw the source of the Parbati and lived. I was the first white man to see the source of the Parbati and I still live; of course the Kulu people put it down to my relationship with Jhemlu. The priest at Manikaran put it down to the fact that I excavated and restored a very old temple of Raghonathji; and for my services to the temple they took me into the temple and showed me the hot geyser, about 8 or 9 feet high, which is not usually shown. My idea was that if that road had been taken up as a trade route and a track made of some sort on the hillside above the last 4 miles of the glacier, it would be a perfectly easy road, and you could ride across it on a Spiti pony. But, unfortunately, the Spiti people were dead against anybody going there, and they were afraid the Kulu people would come in and steal from them, while the Kulu people professed the same fear and did not want to be bothered by travellers. So I did not succeed in getting anybody to go over the pass for some years. I think Mr. Skemp went over it ten years ago.

I am glad that Mr. Shuttleworth was able to use his camera. In my own time there were nothing but wet plates, and it would have been impossible to carry a camera in the sort of country one went over. He has shown us most beautiful pictures, which make me feel I could go back to Kulu and live it all over again.

The PRESIDENT: You can understand how very popular Kulu is among Lieutenant-Governors of the Punjab. We have another ex-Governor present, Sir Michael O'Dwyer; perhaps he would like to add to the discussion.

Sir MICHAEL O'DWYER: I can claim only a very slight acquaintance with Kulu. The fact is that in the days of my distinguished predecessor (Sir L. Dane), both on this platform and in the Punjab, Kulu was so popular, and that not only with Lieutenant-Governors but with other officials, that it became necessary in the interest of the administration to put Kulu out of bounds, and I had to give an example of my self-denying ordinance which

limited me to one brief tour extending over a few weeks. I am, therefore, able to tell you very little about it, but one thing I can claim: that I was responsible indirectly for the delightful lecture and slides we have seen this evening, because it was when I was Lieutenant-Governor that Mr. Shuttleworth was posted to Kulu. Not only that, but I think much of Mr. Shuttleworth's success in Kulu was due to the fact that he had with him in his wife such an intrepid partner in all his journeys. A very famous predecessor of mine in the Punjab, Sir John Lawrence, used to say that when he found a young Assistant Commissioner with a wife and a piano, he hustled him about from pillar to post until he first dropped the wife and then the piano. In my day we were more considerate, and I may say that one of my reasons for posting Mr. Shuttleworth to Kulu was the fact that the maiden name of Mrs. Shuttleworth was MacGillicuddy—MacGillicuddy of the Reeks—and I thought a young lady who at home was in the habit of running up MacGillicuddy's Reeks would equally be at home at 18,000 feet in the Himalayas. As a result you saw her in one of the pictures at a height of 17,000 feet, and I am sure you realized that she was to the manner born. Mr. Shuttleworth had not to drop his wife, nor his camera, fortunately for us.

There is very little that I need say about Kulu. There is one weird function that I witnessed. We have been told a lot about the local gods and the large part they play in the interior economy of the valley. I was privileged in October 1917 to be present at the great annual meeting of the gods at Sultanpur, when all the gods from all the villages are brought in to pay homage to the great god Raghonathji and to one another. I thought I would stroll down to see what went on, but as the Lieutenant-Governor I was hauled up on to a dais before I knew what was intended, and was told that all the gods would march past and salute me, and I was to receive the salute. There was no way out of it. I felt tremendously honoured and also much embarrassed. All the gods of Kulu, preceded by Raghonathji, marched past and I returned their salute.

So far as regards Hindu Kulu. A few days afterwards I was going up the valley on the way up the Rohtang pass, and I met the Nono of Spiti, the head of the Buddhist religion. He is something like the Dalai Lama, and is the spiritual and (under Government) civil authority in this remote valley of Spiti. The previous Nono had died the year before, and the new Nono had been appointed by the Spiti College of Cardinals, and came in to receive investiture from the Lieutenant-Governor. I happened to meet him, very tired after his long journey over the pass, and we had a most pleasant interview, in which I gave him due recognition and increased his poor temporalities by giving him a larger share in the income of the Principality. It is only to-night that I have heard that his good fortune did not last long, and that he was succeeded by the boy we saw on the screen.

There is one little fact I might mention. Lahul is perhaps the most remote corner of British India, being 150 miles away from the nearest railway, and is only reached by the Rohtang pass about 14,000 feet high. I was there at the outbreak of the war, the echoes of which resounded as far as Lahul. The people of those parts are extremely peaceful; for generations they have had no fighting to do, but they knew the British Empire was at war, and that it was a time when the King-Emperor expected his people to rally to his assistance. At that time all our fighting forces in the Punjab were being drained dry. We had sent a quarter of a million combatants to the colours. The local Thakur or Rajah came to me in October 1916 and said, "Sahib, I am a

man of peace, but if necessary I am willing to fight." I said, "We are getting our fighting men from the plains." "But," he said, "how can I help?" I said, "At the present time the Government is very sadly in need of a Labour Corps in Mesopotamia," and I told him where it was; "but you would not be fit to go into Mesopotamia. You could not leave your snow-clad mountains and shady valley and go to the wastes of Mesopotamia." He replied, "Sahib, I am going. I will take two hundred of my men with me." He passed me his word, and before six weeks were over that man, at the beginning of the winter, that is to say in October, had left these tremendous heights and the snowy mountains and taken two hundred of his merry men with him and gone to work in the arid and sun-smitten wastes of Mesopotamia, to do his bit in the Great War. They remained for six months there, and did admirable work. Probably not more than two or three of that intrepid band had ever left their mountain passes before, yet for a great cause they risked everything. One might have heard of more showy deeds, but not of any more genuine testimony to the loyalty and spirit of these people in these remote mountain passes than that one single effort.

The PRESIDENT: Sir Louis Dane first went to Kulu in the year 1880, but there is a gentleman here to-night who was there a good many years before. I do not know whether Mr. Coldstream would like to corroborate what has been said about the beauties of Kulu.

Mr. W. COLDSTREAM: Of those who are present in this audience I am probably the first who was in that interesting land which the lecturer described. I was there as Assistant Commissioner in the year 1866. I found it a most interesting sphere of work in those days, and it has been a great pleasure to me to watch the development of Kulu. I hope that it may go on and flourish, and may have a great many as zealous and enterprising officers to carry on the administration as those whom you have seen on this platform to-night.

The PRESIDENT: I know that you will all wish me to thank our lecturer, Mr. Shuttleworth, for giving us a most vivid description of that wonderful and delightful land over which he ruled for a year or two; but especially for having brought back to us those photographs which have given us a very clear idea of the magnificence of the scenery.

THE EVIDENCE OF A TRUE NORTH AND SOUTH DIRECTIVE FORCE IN THE ATMOSPHERE

E. A. Reeves, Map Curator and Instructor in Surveying, R.G.S.

Read at the Afternoon Meeting of the Society, 15 *May* 1922

ABOUT four years ago, at one of the afternoon meetings of this Society I read a paper on "A Transformation of the Magnetic Dip Curves," * and at the end of the paper stated that I hoped on some future occasion to place before the meeting the results of experiments which I had been making for some time past in connection with the subject. These experiments were commenced about 1911 and have been continued ever since when possible, not only by myself in this country,

* Published in the *Geographical Journal* for March 1919.

but by others in different parts of the world; and it appeared to me that it might be of some interest to place the results before you this afternoon, which I do with the hope that it may be found eventually that the subject will throw light on some obscure problems in physical geography.

In the paper referred to I confined myself to setting forth the results arrived at by transforming the Equal Magnet Dip or Inclination curves as they are generally laid down on charts, and showing what they would become if measured from the earth's rotation or geographical axis as a common axis of reference, instead of the varying horizon lines. The effect of the Declination was also taken into consideration, and in fact the new Equal Axial Inclination curves show the angles that a freely suspended magnetic needle, when at rest, makes with the geographical axis of the earth. These new curves tend, in a general way, to range themselves round the geographical poles, and are much more regular in form than the ordinary Dip curves, although they are drawn out in the direction of the areas of maximum magnetic total intensity in high latitudes, as one would expect them to be. In fact they appear to me to be consistent with the supposition that the earth's magnetism is connected with the rotation of the earth, in an electric field of the atmosphere, in which, as a consequence, the lines of force are normally in line with the geographical or rotation axis, although the magnetic axis is inclined at a certain angle to this, owing probably to the unequal magnetic permeability of the material of which the earth's crust is composed. Further support seems to be furnished by the connection between the mean of the Axial Inclination angles and geographical latitudes which is brought out in my paper, and confirmation is, I believe, also furnished by what I now have to refer to.

Taking the conclusions arrived at as a reasonable hypothesis, I sought to find further confirmation, and felt that there might perhaps be some method of observation by which the direction of the horizontal lines of force in a static electric field in the atmosphere near the earth's surface could be detected, supposing such to exist, which appeared probable. The method of experiment I finally decided on is similar in principle to that given in elementary text-books on magnetism and electricity, such as Hadley's, for finding the directions of lines of force in an electric field, only I use a flat disc of thin paper or aluminium instead of two pith balls, and enclose the apparatus in a glass receptacle. I have used many materials for the indicating pointer, including two light balls connected and arranged as in the pith-ball experiment, always with much the same result.

I could see that the observation would be beset with great difficulties, owing to the fact that if this static electric field is due, as I supposed, to the strain in the atmosphere between two highly charged areas above the Polar Regions, it would be necessary to make the experiments at great altitudes to obtain really satisfactory results, owing to deflections in the

lines of force due to irregularities on the earth's surface, clouds, radiation, and other causes. In fact the ideal observations would be those taken above the clouds. It was clear that only under the most favourable weather and other circumstances could any good results be obtained, and this has proved to be the case; but I think it must be admitted, from the reports which I have received from different parts of the world, that the evidence already obtained shows that some such north and south directive force as I imagined does exist, whatever its cause may be.

Later on I shall venture to suggest what appears to me to be the probable explanation of this hitherto unknown directive force, and whether my theory proves, in the main, to be right or wrong, it is an interesting fact that it was the supposed existence of these lines of force that led to the experiments and results: and it would surely be remarkable, if the theory were altogether erroneous, that the results obtained are exactly those expected from it.

The apparatus first used for the purpose of the experiment consisted merely of a strip of thin light paper suspended on the fine point of a glass rod thrust through the centre of the wooden base of a circular glass dome shade, and the whole mounted on a tripod stand. This apparatus was, on fine clear days, set up on hilltops, right away from any higher ground, trees, or buildings, and the strip of paper was then left to take up any position it might. Although the apparatus was somewhat crude and in certain respects unsatisfactory, it was frequently found that the paper pointer came to rest within a few degrees of the True North and South line, and it was at once clear that there was no tendency to place itself in line with the magnetic meridian, or point magnetic North as does an ordinary compass needle. With this apparatus there was considerable difficulty with wind, friction, and in balancing the strip of paper on the pivot, so I never felt sure of the results obtained, although confident in my own mind that there was a tendency to point True North and South; but now with the improved apparatus I have recently constructed I have no hesitation in stating that under suitable conditions this is certainly the case, at any rate in those places mentioned in the appended reports where the experiments have been carried out. In clear, fine, dry weather, with a steady and fairly high barometer, or better still if a rising barometer, when the apparatus is set up in high open spaces on hilltops, with no higher ground, trees, or obstructions of any kind near, and protected from the direct rays of the sun, the pointer indicates the True North and South direction, either, as is frequently the case, by oscillating though a small angle on either side of that direction, or by coming to rest in this line. The most satisfactory results have been obtained on fine clear days in frosty weather with practically no wind. The directive force appears to be strongest in the evening and morning, but successful observations have been made at many other times, and at all seasons of the year with the sun at every possible bearing round the horizon.

Sometimes the direction indicated is almost exactly True North and South, at others within 3 to 5 degrees, and the difference is as likely to be on one side as the other. In frosty weather I have frequently obtained good results even when there has been a low ground fog, provided the sky is clear above.

In the earlier stages of the experiments the paper pointer was always electrified by touching it with rubbed vulcanite, but this does not appear to be necessary, and is now never done. The apparatus used later on, and with which nearly all the experiments were taken, is an improvement on the earlier form. It consists of a large wide-mouthed glass bottle with an indiarubber stopper, from the centre of which is suspended by a single fibre of unspun silk, an oval-shaped piece of flat thin paper. The bottle is coated inside and out with shellac varnish, the under side of the india-rubber stopper from which the silk fibre with the paper pointer is suspended is covered with paraffin wax, and the whole rests upon a tripod stand. It is with this form of apparatus that the observations taken abroad so far have been made. I now frequently use the same kind of apparatus, but find very thin flat aluminium much better than paper, and instead of one disc or ring only, have two close together and parallel rings joined at the top and suspended by a single fibre. The longer the silk fibre is the better, and in order to increase the length I have recently placed a glass tube through the stopper and suspended the silk from the top of this as shown in Fig. 1. When the experiment is made it is important to see that the apparatus is levelled, and that the indicator disc or ring is in the centre of the bottle and stand. The bottle should be of thin glass of even thickness and as large as possible, with as long a neck as possible and circular in form.

When the apparatus is used it is carefully set up as shown in the figure, and the observer then steps back a considerable distance so that there should be no chance of his attracting the indicator towards himself, and awaits results. The indicator begins slowly to adjust itself, and after about fifteen or twenty minutes, or sometimes longer, it is generally found that, with a paper disc, it is oscillating, sometimes quite rapidly, about evenly through an angle of perhaps 10° to 15° or more. With the aluminium it is much steadier: frequently there is little or no oscillation. The bearing of the middle position is then taken with a prismatic compass, and this, after allowing for "variation," has been found to be within a few degrees of the True North and South line.

The average period of oscillation with the paper indicator is generally about 5 secs. of time, but this varies according to the strength of the directive force. With the aluminium indicator there is usually little or no oscillation, and if any it is much slower.

At times the pointer moves round very slowly, almost inappreciably, and after a considerable time becomes stationary; when it does so its position is very nearly True North and South. If the bottle is turned

round the paper will usually take up about the same position again in about fifteen or twenty minutes. Between 6 to 10 a.m. and 4 to 9 p.m. are satisfactory hours to make the experiment, and these times seem roughly to coincide with the maximum position of the vertical potential gradient curve of atmospheric electricity (see Dr. W. F. G. Swann's article in the *Journal of the Franklin Institute*, Nov. 1919). It is advisable to wipe the outside of the bottle occasionally with a cloth if there should be evidence of moisture, and the inside and the paper must be kept

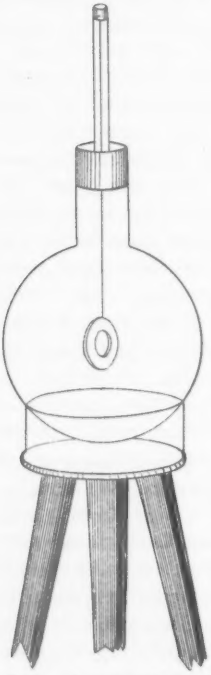


Fig. 1.—Latest pattern of apparatus with suspended disc.

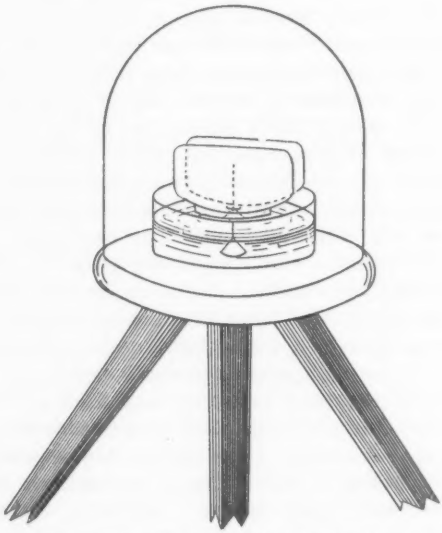


Fig. 2.—Alternative pattern with floating discs.

absolutely dry. I have at times got good results by placing the bottle right on a level piece of ground when the result has not been very decisive upon a high stand. In wet weather, or when there are low rain or thunder clouds about, or the barometer is falling, it is useless to attempt the experiment: the clouds themselves become electrified and may be oppositely charged, so that no definite results can be expected. To equalize the temperature of the air in the bottle and prevent convection currents as far as possible, it is well to lift the stopper from the bottle occasionally so as to admit fresh air. This will also help to

dissipate any "secondary fields" that may tend to form on the inside of the bottle. To obviate any difficulty with torsion in the silk fibre by which the discs or rings are suspended I have recently experimented with a form of floating apparatus, which seems satisfactory. This consists of two vertical parallel discs of the thinnest possible aluminium sheet (about $3\frac{1}{2} \times 2$ inches) $\frac{3}{4}$ inch apart, fixed on a circular flat piece of cork, which floats in a circular glass bowl about half filled with paraffin oil. The vertical discs are cut out of one piece of aluminium, with a narrow strip left between them to form a base for fastening on to the cork. In the centre of this base strip is a small hole, with a much larger hole in the centre of the cork float, and through these passes a vertical needle fastened in the centre of the bottom of the glass bowl. The discs can thus rotate freely and keep their central position. The glass bowl is coated with shellac varnish, and the whole is covered with a glass dome shade also coated with shellac varnish, and mounted upon a tripod stand as shown (Fig. 2).

My own observations have been confined to the south of England and the neighbourhood of London, but friends accustomed to scientific work have carried out similar experiments for me in other parts of the world. A request for co-operation in this experiment was published in the *Geographical Journal* for September 1920, and this has resulted in several valuable reports which have been sent to me from time to time. During three successive days in September 1919 Mr. Rowe of the British East Africa Government Survey, who was home on leave, took observations in Essex with an apparatus made by himself to my design, and the mean of his results was half a degree west of true north, while none of the readings differed more than two or three degrees from that direction. Mr. H. T. Burls and many others have seen it work at the Royal Geographical Society. Dr. Deville, the Surveyor-General of Canada, has made experiments near Ottawa, and Dr. Hamilton Rice has been experimenting for me near Newport, Rhode island, U.S.A., whilst more recently still Mr. Godfrey Sykes of the Desert Laboratory, Tucson, Arizona, U.S.A., has been carrying out most successfully a series of observations at that place. The experiments have also been made by Captain C. Groves, R.N.R., in the south of Spain and at Perim Island at the entrance of the Red Sea, and by several others, among the more important of which are those of Mr. R. T. Stobart, a physicist of the Oxford University Expedition to Spitsbergen in the summer of 1921, and some of Lieut. Forsyth near Port Harcourt in Nigeria and on the summit of the highest peak of the Cameroons Mountain (Mount Fako) at an altitude of 13,350 feet. All these observers, extracts of whose reports I append, have obtained evidence of a True North and South directive force, as I and others have in this country. The area over which satisfactory experiments have been made is already very large, extending from lat. 80° N. to close to the Equator, and from the Western States of America to the Red Sea. It is hoped

that more may be induced to make the experiment in other countries as opportunity occurs.

In only a very few cases have the results sent me from abroad been indefinite and inconclusive, and these have almost all been of experiments taken with admittedly imperfect apparatus or under unsuitable conditions, and I was asked not to take them as final.

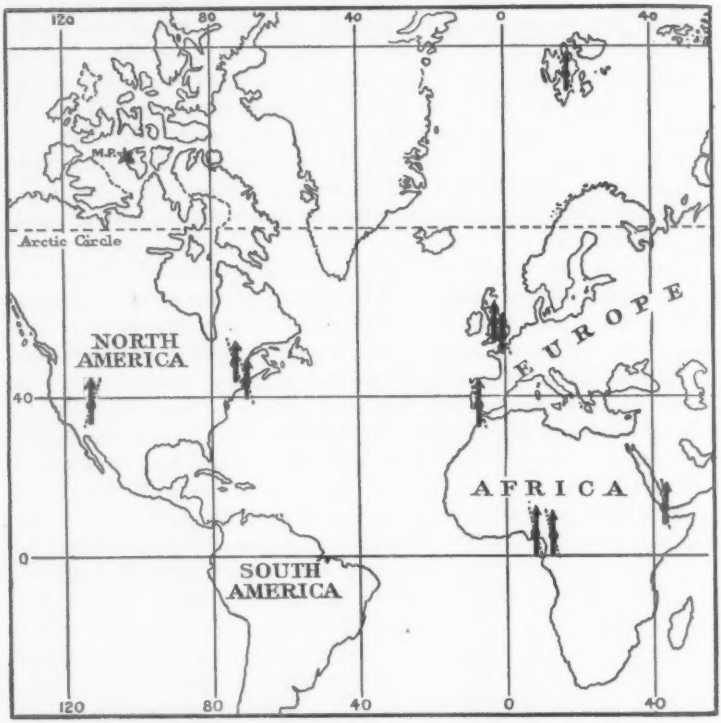


Fig. 3.—Chart showing distribution of stations and results of experiments with the apparatus.

The accompanying chart (Fig. 3) shows the results of experiments taken under the conditions I laid down, with the direction indicated by the pointer shown by an arrow. The thin dotted lines give the magnetic north and south direction for each place.

The following table will give a good idea of the results I have obtained during the last few years. Many other observations might have been added, but the mean result would have come out about the same.

HIGHGATE ROAD (IN GARDEN).

1919.	*Mean Magnetic Bearing of Pointer.*	*Mean of Set.*	*Variation from True North.*
June 21st, 4 p.m. to 6 p.m.	° 12·5, 15·0, 19 0, 18·0, 17·0	16°·3	2°·1 E.
July 18th, 9 to 9.45 p.m	15·0, 12·5	13·7	0·5 W.
1920.			
March 21st, 9 a m.	14·5	14·7	0·3 E.
6 p.m.	15·0		
,, 26th, 8.30 a.m.	14·5	—	0·3 E.
1921.			
July 10th, 8 a.m.	15	—	0·7 E.
Sept. 24th, 6.50 to 8.10 a.m. ...	16 (pointer stationary)		
,, 8.30	15		
apparatus turned about 90° to right		14·7	0·4
8.40	19		
apparatus turned about 90° to left			
8.50	9		

HAMPSTEAD HEATH.

1919.	°		
July 12th, 11 a.m. to noon ...	8, 18, 10	12°	2°·2 W.
1920.			
April 6th, 7.45 a.m.	14	—	0·2 W.

REDHILL COMMON (SURREY).

1919.	°		
Aug. 5th, 6.45 to 8 p.m	13, 16, 15, 14	14°·5	0°·3 E.
,, 11th, 7.15 to 7.45 a.m. (taken during magnetic storm) ...	1, 20, 14	11·7	2·5 W.
,, 12th, 7.20 to 7.40 a.m. ...	14, 15	14·5	0·3 E.
,, 13th, 7 to 7.15 a.m. and 9.15 to 9.45 p.m.	13 5, 16·5, 14, 15	14·7	0·5 E.

LEWES (SUSSEX).

1920.	°		
Aug. 23rd, 7 to 8 a.m.	16, 18, 15	16°·3	2°·5 E.
,, 28th, 8 to 9 p.m.	17, 15, 14	15·3	1·5 E.

Early in last year Dr. G. C. Simpson, the Director of the Meteorological Office, became interested in this subject, and an assistant, Mr. Watson, has made experiments at the Kew Observatory on his behalf. I have received altogether three letters from Dr. Simpson, and in the last of these he states that through pressure of other work he has, for the time, been compelled to abandon the experiments without coming to any definite conclusions. After experimenting for about five months, he stated in his first letter that without committing himself to anything definite "there is little doubt that some approximately north and south force does act upon the disc, and that this force is not magnetic."

As I pointed out, one essential condition for success is that the experiment should be carried out in clear weather on high ground, preferably a high hilltop, with no higher ground or obstructions in the neighbourhood, and further that there should be no inequalities of temperature in the surrounding atmosphere. Kew is only 15 feet above sea-level and close to the river Thames, so it is a most unfavourable place for the experiment. Then, as Dr. Simpson states, the experiments at Kew have differed in principle and method from mine, and many of them have been made indoors under all sorts of weather conditions, so that under the circumstances it is not surprising that no very definite results were obtained. However, even there the observations seem to have indicated a preponderance of approximate north and south directions, and when I was there on a favourable day in August of last year watching an assistant make his experiments, all the results but one came within 2° or 3° of the True North and South line. During rain, or when the sky is thickly overcast, or the barometer is falling, I have frequently noticed that there is a decided tendency for the pointer to turn towards the thickest part of the clouded sky, or to take up an approximate east and west direction, and this occurred on the two other occasions when I was at Kew under these weather conditions.

A preliminary report sent to me from Disko Island, Greenland, indicates this tendency for the pointer to take up a direction at right angles to the earth's rotation axis when the sky is clouded and the barometer falling, and under these unfavourable weather conditions the same tendency has been noticed by other observers.

The conditions under which the experiment succeeds appear to be exactly those that would be necessary for any electrical experiment of the kind, and the fact that no definite results can be obtained with a falling barometer in wet or cloudy weather or when there is thunder about, seem to show that the cause of the True North and South orientation is *electrical* and not due to another cause altogether. During thunderstorms I have noticed that the disc will turn to the darkest part of the clouded sky, until the sky clears again.

An interesting fact that seems worth recording is that during the eclipse of the sun on 7 April 1921, careful experiments were made in

two places in London to see if this had any effect on the north and south directive force, and in both cases the result was most remarkable. I had charge of one apparatus at South Kensington and another was left at Highgate. In both cases the north and south directive force appeared quite strong and definite until the commencement of the eclipse, during which in one case the pointer turned through an angle of about 90°, and remained in that position until the eclipse was over, when it immediately returned to its former north and south position; and in the other case the pointer, which like the first had been standing north and south, seemed to lose all directive force and swung round indefinitely, but promptly resumed its north and south direction again after the sun had cleared. This seems to show that the phenomenon is connected with the streams of electrons emanating from the sun.

It is not necessarily the elongated diameter that turns north and south. For instance, if a strip of aluminium, about 1 inch wide, is coiled round into the form of a ring and then flattened so that the sides almost touch each other, when suspended vertically the flat sides turn north and south as in the case of the ordinary discs. Now, if these flat surfaces are pulled out so as to form a ring with the elongated horizontal diameter several times as long as the breadth of the strip, it is not this elongated diameter that turns north and south, but the surface breadth of the strip as before. In fact there is no alteration in the direction, but the surface sides of the aluminium strip take up the same direction as when they were flattened close together.

As to the reason of this tendency for the non-magnetic pointer to take up an approximately True North and South direction in clear fine weather, it is perhaps too early to speak definitely, but I think it will be found that this directive force is, in the main, electric. Had it been due to any other cause (such as gravity), clouds, state of the barometer, wind, local irregularities or moisture, could not possibly affect it, as they have been proved to do, even if any purely gravitational theory could account for this directional tendency, which appears impossible. This question has been discussed by Sir Arthur Schuster, Colonel Grove-Hills, Mr. W. D. Lambert (of the U.S. Coast and Geodetic Survey), and myself in the letters that appeared in *Nature* for 20 October, 24 November, 1 December, and 22 December 1921, and 2 March 1922, and I think all must have come to the conclusion that no purely gravitational theory will explain the phenomenon.

Mr. W. D. Lambert, in his communication of March 2 last, admits that the gravitational theory seems inadequate, and in a letter to me states that, as I suggest, "*the effect of an electric field seems a more probable explanation.*"

Ordinary temperature radiation, or the direction in which the light falls on the pointer, can have little to do with the real cause of this north and south directive force, since the experiments have been made at all

hours of the day and at different seasons of the year, with the sun at all possible declinations and azimuths, with much the same result. As Dr. Simpson states, radiation *does* enter into the experiment very seriously, but only as a disturbing element, and after careful tests I can say that it has nothing to do with the primary cause. In some of the reports from abroad tests have been made by the observer for radiation effect, with the same results that I have found myself. In no case has the pointer been found to follow the sun round the horizon at different hours of the day.

The most reasonable explanation appears to be that over the earth's polar areas there are highly electrified regions of the atmosphere, and these produce a "strain" throughout the crust of the earth and lower strata of the poorly conductive atmosphere, resulting in the usual lines of force, which would naturally follow approximately the true meridians.

These highly electrified polar areas are probably caused, either directly or indirectly, by the incessant streams of electrons which according to investigations in recent years on the auroræ and atmospheric electricity appear to be drawn in towards the earth in the polar regions by electro-magnetic agency, as evidenced by the auroræ (see recent researches of Birkeland, Störmer, and others). It is interesting to note that the curves of aurora "frequency," in the North Polar regions at any rate (I can find no chart of them for the South Polar regions), agree fairly well with the curves of Equal Axial Inclination as shown on my magnetic charts given in the *Geographical Journal* for March 1919, as regards their centres and tendency to elongate in the direction of the magnetic total force centres, although the inner aurora curves appear to pass over more to the east of Siberia than mine do (see Figs. 4 and 5). The "frequency" curves of the Aurora Borealis as shown on Fig. 5 are taken from the chart in vol. 22, *Ter. Mag.*, after Störmer, and it seems probable that the curves of greatest frequency indicate roughly the limits of the higher electric potential area in the North Polar area.

If we suppose the electricity of the atmosphere over the North and South Polar regions to be of a higher potential than that of the intermediate atmosphere of about the same altitude and to be oppositely charged (one polar area − and the other +), the lines of force would follow the true meridians, and the indicator of the apparatus would align itself approximately True North and South; but if they were similarly charged, either both + or both −, then they would diverge and tend to curve outwards and upwards somewhere between the two charged areas, and if these latter were both equal in potential and extent, this divergence would occur near the equator. But this does not appear to be the case, since the result of experiments in latitude 4° N. on the top of the Cameroons Mountain are very definite, and it would seem that if this divergence in the lines of force and consequent uncertainty of direction indicated by the experiments exists, it must be around some zone of latitude somewhere between the equator and South Polar Regions,

in which case the indication would seem to be that the Polar Regions are both similarly charged, and that the North Polar area is stronger than

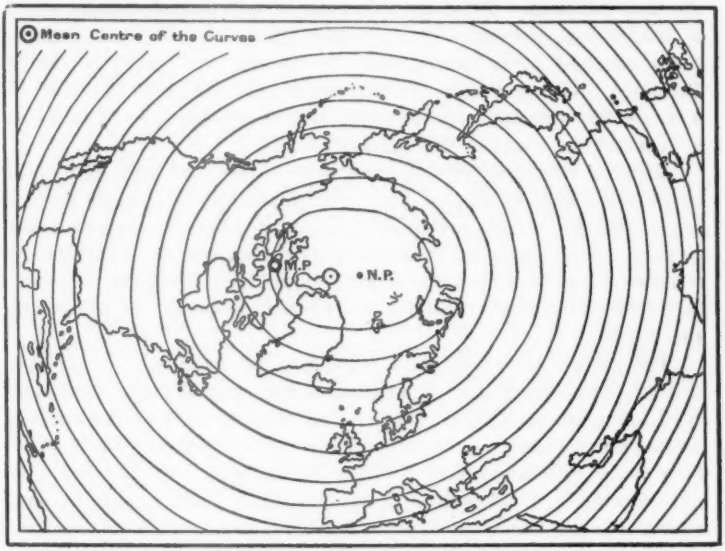


Fig. 4.—Curves of Equal Axial Inclination.

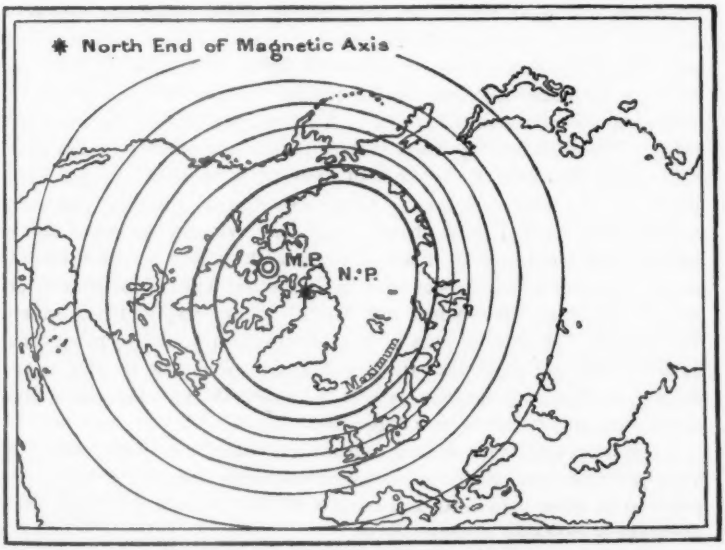


Fig. 5.—Curves of Equal Frequency of Aurora.

that of the South. In very high latitudes within the curves of maximum auroral frequency and intensity there is not likely to be any very definite direction indicated. These are wide areas of high electric charges, which probably vary considerably in certain parts according to weather conditions and other causes, and the pointer may take up various directions. Then the lines of force would, in these high latitudes, be more or less vertical, with the result that there would be little or no horizontal force acting on the indicator.

So far as I can see, there appears to be nothing unreasonable in the tentative explanation which I have offered, and the facts upon which I have based the theory are those now pretty generally recognized and given by recent writers on atmospheric electricity (see Dr. S. Chapman's paper on "Electrical Phenomena occurring in High Levels in the Atmosphere," read before the Institute of Electrical Engineers, 24 April 1919, and others).

The highly electrified polar areas may be expected to vary considerably according to the declination of the sun and other causes, and in all latitudes it is evident that the lines of force will be deflected by clouds, which themselves become electrically charged, frequently oppositely to the clear atmosphere (see Dr. Swann, paper already referred to, and elsewhere), so altogether it seems certain that, except in clear weather, the direction of the indicator is liable to considerable variation from the true north and south direction. Again, dampness in the atmosphere would tend to vitiate any results of experiments, as the moisture on the apparatus and in its immediate surroundings would cause the insulation to break down. As might be expected, too, obstructions such as steep hill slopes, buildings, trees, etc., would deflect the lines of force and alter the direction taken up by the pointer. Then there is always the chance of secondary electric fields and convection currents in the apparatus. It is therefore apparent that to obtain any reliable results as to the *normal* direction of the lines of force, it is necessary to use every precaution to ensure accuracy. If the experiment is carried out under suitable conditions, I think there is sufficient evidence furnished by the results already obtained in different parts of the world to show that the *normal* direction of the lines of force in the electric fields of the atmosphere is approximately True North and South, at any rate in the Northern Hemisphere. How these lines of force originate may require much fuller experimental and theoretical work than I have been able to give to the subject, but that they exist there seems to be little doubt. My idea of their cause must only be taken as a suggestion.

It is important that further experiments should be made, for if in some parts the general normal direction under the conditions laid down prove to be other than north and south it will be interesting to learn what direction is indicated at these places.

Summary of Observations with Mr. Reeves's Apparatus at Different Stations.

I. Leigh-on-Sea. Mr. C. H. Rowe (Attached Survey Dept., Tanganyika Territory).

1919, Sept. 12, 13, 14. Weather sunny; temp. about 70°. F. Height about 100 feet.

Mean of observations, ½° west of true north.

II. Ottawa. Department of the Interior. Mr. E. Deville, Surveyor-General.

From letter dated 9 October 1920 :

Since receiving your letter of June 30 containing additional information with regard to conducting an experiment to detect the horizontal static electric field of the atmosphere, we have on several occasions repeated this experiment. The apparatus was set up according to the instructions you supplied on the most suitable spot that could be found in the immediate vicinity of Ottawa.

It was noticed that in each trial the suspended paper tended to vibrate about the true north and south direction, but that it did not come to rest during the period of one hour or more spent on the observation. The amplitude of the vibrations varied considerably; sometimes the vane would be nearly at rest, when the swings would quickly become quite large, as though there were some disturbing influence involved. This effect was noticed in all the observations (care being taken that the observers were not sufficiently close to influence the indications). Owing to the variations in amplitude of the swing it was somewhat difficult to obtain the mean direction.

In most of the observations, however, the needle was found to vibrate about a line within ±3° of true north-south line.

III. Newport, Rhode Island. Dr. Hamilton Rice.

From letter dated 10 November 1920 :

I have taken advantage of the good days that we have had, whenever I have been here, for carrying out your experiment, and find that the tendency is for the paper to come to rest in a true north and south line.

The trouble thus far has been a general unsteadiness of the paper to remain at rest for any length of time, oscillating again soon after it has come to rest, the oscillations slowing down usually to slow swings 10° to 15° each side of the true north and south line. . . .

IV. Port Harcourt, Southern Nigeria. R. B. W. Forsyth, Lieut. R.N.R., Nigeria Marine Survey.

13 March 1921, 5.30–6.30 p.m., about 22 miles from coast.

The suspended paper, after a lapse of about ten minutes, settled down to a steady swing, the amplitudes of the vibrations being approximately 7° ± of the true north.

At various intervals (approximately five minutes) the paper consistently took up a true north and south position, but steadying only for the space of about five seconds, when it would again commence swinging slowly, but never more than 7° to 8° on each side of the true north and south line.

Bearings were taken by prismatic compass which has been tested from base observations at Sand Island.

V. Bonanza, River Guadalquivir, and Perim Island. Charles A. Groves, Master S.S. *Sheaf Spear*, Lieut. R.N.R.

From letter dated 28 March 1921 :

. . . After leaving the Levant I constructed a new apparatus, consisting of a large glass flask similar to those we used in the chemical laboratory in our school days, and coated with shellac and fitted with a rubber stopper.

My next experiments were conducted close to a place called Bonanza, at the mouth of the river Guadalquivir, where the variation is 14° westerly. The position was on the river-bank some 2 miles from any building and amongst some very low-growing cactus. The temperature was 72° F., and the barometer stood at 30·45 on January 2. Sky absolutely cloudless, and but the merest zephyr from the north-east. I commenced at 9.30 a.m. and carried out a great number of observations at periods from 15 to 40 minutes. The mean positions taken up by the paper were N. 80° E. before electrifying, and next day, after electrifying the paper, N. 6° E. I found here that when the paper was not rubbed with vulcanite it remained practically stationary, but afterwards it very gently swung continuously through an arc of 5 degrees. On the opposite side of the river there was a very extensive wood, but the nearest trees were about 1000 yards away. The paper appeared to take up its direction quicker when untouched by the vulcanite.

On May 27 I made further observations with the same apparatus on this island [Perim], where the variation is nil, and at a height of about 80 feet above sea-level. The barometer stood at 29·9 and the thermometer at 80° in the shade. The sky was cloudless and a very light southerly breeze was blowing, but the apparatus was well protected from it. The nearest building was a mile distant, and of course there are no trees on the island. The time was 5.45 p.m., and the following results were obtained.

In thirty-five minutes the paper came to rest steady in a N. 11° E. direction without electrification, and this proved to be the mean direction of the two observations with the paper unelectrified, and of two observations after rubbing it with vulcanite.

On all occasions after an observation has been taken the bottle has been lifted from its stand and turned at least 45 degrees.

VI. Cameroons Mountain (Fako, 13,353 feet). R. B. W. Forsyth, Lieut. R.N.R., Nigerian Marine Survey.

25 September 1921. 1.10 to 1.50 p.m.

The true meridian was laid out by means of prismatic compass, 10° westerly variation being allowed.

At 1.10 p.m. the globular bottle was in position. For a period of six minutes the suspended paper swung sharply in an amplitude of 30° to 50° ± of the true north, the amplitudes of the vibrations gradually decreasing until at 1.20 p.m. a steady slow swing of 10° ± was experienced.

Between 1.20 and 1.30 p.m. on three separate occasions the paper swung sharply to the westward, approximately 30°, and each time returning slowly to the original amplitude of swing (10° ±).

From 1.30 to 1.50 p.m. the paper was practically steady on a true north and south line, only a very slight vibration being perceptible. Light easterly wind with passing banks of mist prevailed throughout the experiments. Temperature 38° F.

VII. Spitsbergen. Mr. R. F. Stobart, Oxford University Expedition, 1921.

The observations bring out the following points:

(1) The disc tends to set approximately north and south during fine settled weather, but becomes erratic during the approach of bad weather and wind.

(2) That whatever forces were acting on the disc were continually varying in intensity.

(3) That direct sunlight appeared to cause convection currents or radiometer action, but did not alter the direction of the disc to any great extent.

VIII. Tucson, Arizona. Mr. Godfrey Sykes, of the Desert Laboratory, Carnegie Institution.

Summit of isolated hill, about 600 feet above surrounding country, and 3000 feet above sea.

Conclusions from several experiments:

(1) There is undoubtedly *some* force which tends to bring the paper into an approximately true north and south line.

(2) The period just before sunset is the best for results.

(3) That direct sunlight upon the glass container gives rise to considerable vibration.

(4) When the paper is first suspended and the container closed, a period of from five to fifteen minutes must be allowed for the paper to come into the meridian, and generally from then on it will only vibrate slightly (about 5° to 10°) on each side of the meridian.

Before the paper the PRESIDENT said: There is not much need to introduce Mr. Reeves. It is rather for Mr. Reeves to introduce most of us. He is going to give us an address this evening upon some very remarkable experiments which he has been making for some years past upon what appears to be an unknown directive force in nature.

Mr. Reeves then read the paper printed above, and a discussion followed.

Lord EDWARD GLEICHEN: I do not know whether it has any bearing on the subject; perhaps it may be entirely unscientific. But I might mention that I know a lady who has rather a peculiar property, that when she finds herself in a dark room she can always find her true north and south by lying on the ground and shifting herself round. This might conceivably have some bearing as to a due north and south force.

Dr. G. C. SIMPSON (Director, Meteorological Office): I think I might describe in a few words the work that the Meteorological Office has done in connection with these experiments of Mr. Reeves's. Some time ago Mr. Reeves came down to my office and showed me the results of the work he had done. All my scientific instincts were up against it, because I knew of no electrical force which could possibly act in the way he described. But still I felt that the papers that he had shown me were so uniform in their results that I must, unless I wished to be considered bigoted or prejudiced, have some experiments made. So we started making experiments at Kew. We had one of the flasks set up, and the most remarkable thing was that after about three or four months' working, when the results were plotted, there was a distinct excess in the north-south direction. But I was rather surprised that we could not get anything at all approaching the consistency Mr. Reeves has shown us. We could never get the index, either indoors or out of doors, to settle down steadily and remain north and south for any length of time; it was only when the readings were examined statistically that we got an excess in the north-south direction. And then it was pointed out to me by the observers at Kew that the excess could very well be accounted for in that certain of our experiments had been made with the illumination always from the east or west direction, and that it was an accident that we happened to get the instrument in that position; that if there was any effect of radiation this would account for the results obtained. The work is extremely slow. You cannot just put the instrument up and leave it and return in half an hour to see what has happened. We had to take constant observations hour after hour. That is, of course, the only scientific way in which to do it.

All I can say from our experiments is that we have got no results which either prove or disprove Mr. Reeves's statement; it would be necessary to make more experiments with the light coming from different directions, and go through month after month of work before we could hope for any final result. Also it must be remembered that we have used all our observations, not only those that were made in fine weather; some were taken indoors, and probably Mr. Reeves would say that those ought to be scrapped.

There is, however, one thing that I must say: that, whether the observations are right or wrong, the explanation that Mr. Reeves has given will not hold water. I am not prepared to say whether the disc does settle north and south or not, but I am prepared to say there is no electrical force in the atmosphere which could possibly orientate the disc in the direction indicated. In the first place, we know a considerable amount about atmospheric electricity, and have very delicate means of measuring the electrical fields which exist in the atmosphere, and we should not go on year in, year out, making our delicate experiments without detecting a horizontal field; for a horizontal field would give tremendous potential differences between different parts of the Earth. This is the first thing.

Then the second thing is, that, granted there is a fixed electrical horizontal field in the atmosphere, if an instrument like this were set up in it for half an hour, there would be absolutely no electrical field inside. The sphere is an absolute non-conductor; at all events, Mr. Reeves tries to make it so. When first set up, the electrical field does go right through the sphere; but the atmosphere is ionized, and the electrical field drives the ions from the air on to the non-conductor, and very shortly there will be a positive layer of ions deposited on one side of the non-conductor, and negative on the other side, with the consequence that between those two there would be no electrical field.

Then the last diagram shown by Mr. Reeves is rather interesting, in that he puts a lot of positive electricity at the North Pole and a lot of negative at the South, and then says the lines of force travel round the outside of the Earth. I do not think we want much elementary physics to know that if you put any amount of electricity over the North Pole and over the South Pole, the lines of force would go straight through the atmosphere into the ground and straight away through the Earth and out at the other side, and these two charges would be bound together through the Earth without any field whatever going right round the outside.

It is an interesting paper, and I am quite certain that we physicists have got some time or other to take up this experiment quite seriously. The only reason why I dropped it at Kew was because we had a lot of work in hand, and it meant one man spending the whole of his time in making observations.

Mr. R. E. WATSON: Mr. Reeves has stated that certain conditions are necessary for the disc to come into the north and south position, and really the object of the experiments carried out at Kew Observatory was to determine what the most favourable conditions were, so as to reproduce them in the laboratory. First of all, the apparatus was put out of doors, under meteorological conditions similar to those postulated by Mr. Reeves. In general the results were not satisfactory from Mr. Reeves's point of view, asthe disc never came definitely into the north and south direction for any length of time. In the open air it seemed that most of the oscillations of the suspended system were set up by variations in the temperature of the air inside the bottle. The wind seemed to affect the oscillation of the vane most of all, and, generally speaking, if one obtained the mean position of the vane, say, throughout a period of two or three hours and compared it with the mean direction of the

wind, the vane was at right angles to the direction of the wind, showing presumably that there were convection currents set up inside the bottle which tended to set the vane at right angles to the direction of the wind. When the apparatus was shielded by a plane shield placed close up to the bottle, the vane set parallel to the shield, its position being probably controlled by radiation between the shield and vane. In fact, the radiation and heating effects inside the bottle constitute the greatest difficulties to be overcome with this apparatus. In order to try and overcome the difficulty of changes of temperature inside the bottle, the apparatus was immersed in a water-bath which was kept at a constant temperature in a dark room, readings being taken every hour during the daytime for several days. The variation in temperature in the water-bath was then practically nil, but the direction of the disc varied considerably, although, as Dr. Simpson has said, there was a slight preponderance of results in the north and south direction.

From close observation of the apparatus, it seemed that if there is a directive force such as Mr. Reeves describes it must be very small compared with the torsion in the silk fibre. In order to test this, with the apparatus in the water-bath, an air-tight torsion head was put into the bottle instead of the cork, and the torsion head was turned round 90° each evening for a week, the vane being read at every hour the following day. It was found that as the fibre was twisted 90° each evening, so the mean position of the disc the following day had turned through approximately 90° in the same direction in which the torsion had been applied. Thus it was concluded that under the conditions stated the torsion in the fibre was greater than the directive force. The known forces which affect the apparatus out in the open air are considerable, and if there is such a directive force as Mr. Reeves postulates, then the apparatus as at present designed does not seem delicate enough to detect it.

Mr. HINKS: I know absolutely nothing of atmospheric electricity, and therefore have nothing to contribute to the considerable divergence of opinion between Mr. Reeves's suggestion and Dr. Simpson's quite definite decision upon the matter. But I should like to say this: that when Mr. Reeves first brought this experiment to my notice I felt, like Dr. Simpson, profoundly sceptical about the whole thing; but Mr. Reeves has gradually completely converted me to the real and proved truth of the phenomenon, and I should like to make that point particularly clear, because I think that any one might go away, after hearing what Dr. Simpson and Mr. Watson have said, and feel that the experimental basis of the thing was not so good as it might be.

Mr. Reeves, of course, holds a strong opinion about the suitability of Kew —only 15 feet above sea, by no means an open, nice breezy isolated hill—as a place for the experiments. After looking carefully at the list of people who have, in co-operation with Mr. Reeves for at his instigation, made the experiments in different parts of the world, I do feel that their evidence is not at all to be put aside as that of people who would be inclined to find what they were looking for. I should like to say that strongly. I do not think the suggestion that Dr. Simpson made, that there might be a good deal of bias in the observations, is really to be maintained after examining the reports, and especially if he knew the people who had made the observations. I do feel, therefore, that there is a very strong experimental case to be examined by the physicists; and whether, as is probable, they may knock down a dozen explanations, either by the author of the experiments or by one another, at any rate they have an absolute observation which must some day be explained.

And now I should like to ask from Dr. Simpson's great experience, what is the kind of apparatus that he would like to suggest should be installed in order

to get the required observations? I take it that it ought, if possible, to be a self-recording automatic apparatus. Could such an apparatus be made self-recording? Should it be enclosed in a metal case? Would there be any advantages in having it in a bulb exhausted of air? What real reason is there to expect that the falling barometer or onset of thunderstorms would have any effect upon such an apparatus; and, if so, what precautions could be taken to investigate whether or not they have? Because I take it that it is not quite certain yet; Mr. Reeves would not feel positive that he could speak definitely on some of these points any more than he could explain how it was that he thought at first it was desirable to electrify the disc, and afterwards found it was not necessary. That I think is always what happens in these experimental inquiries. You are very frequently driven at first to lay stress upon quite the wrong cause. I can recall some instances better, perhaps, in astronomy than geography. There was a very celebrated case in the improvement of celestial photographs, where the man who had made the most remarkable advances in that art read a paper to explain how he had made those advances and put forward a series of propositions, every one of which was afterwards conclusively disproved. It was quite evident that none of the causes to which he had attributed his success had in fact contributed to it. It is quite likely that something of the same history may eventually be written about Mr. Reeves' discovery. So that I think it would be due to Mr. Reeves that these gentlemen who have kindly looked into the matter would assist him and us with suggestions for further experimental examination of the thing. But I should like to express, at any rate, my own personal faith in the absolute correctness of the very remarkable fact that Mr. Reeves has brought to our notice.

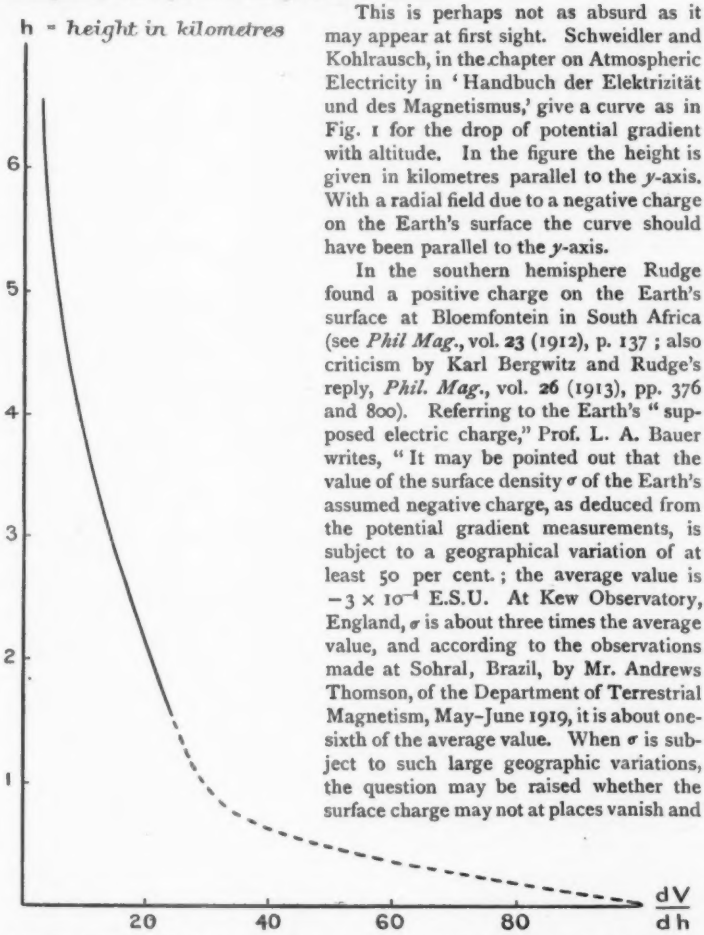
The PRESIDENT: I think really the point we have arrived at now is that it is rather too soon to make an explanation of the phenomenon, but that we want to get the experiments placed upon a sounder basis. Mr. Reeves has described a certain number of experiments under certain conditions; and I understood from Dr. Simpson that he did think there was benefit in continuing the experiments and that Kew would do so. If they could, as Mr. Hinks has suggested, give us advice as to the kind of apparatus most suitable and the conditions under which the observations could be made, I am sure the Fellows of the Society would be only too glad to assist Mr. Reeves, who has devoted so much care and attention to these observations. We all here would like to thank Mr. Reeves for having given us his paper and directed our attention to this certainly very remarkable phenomenon.

A NOTE ON REEVES'S EXPERIMENT

Satyendra Ray, M.Sc., B.A.

IN a paper communicated to the *Phil. Mag.*, January 1920, on the "Equivalent Shell of a Circular Current," it has been shown that a magnetic pole in motion in a circle with a velocity v is equivalent to a dielectric shell with a positive charge on one face and a negative charge on the other. As a first approximation the Earth's magnetic field is attributed to a small magnet at its centre inclined at an angle to the axis of rotation. Each pole m gives us an equivalent shell of total charge e given by the equation $e = AKvm$, where K is the dielective constant, A a numerical constant, and v the linear velocity of the charge m. On account of the inclination of the magnetic axis to the Earth's axis of rotation the value of v for the north and south poles of the Earth's magnet are different, so that we should by the Earth's rotation get a

resultant electric *dipole* field. In other words, the Earth's electrical field instead of being radial would be parallel to the Earth's magnetic field. If the pole in the northern hemisphere be describing a bigger circle than the pole in the southern hemisphere, we should have a negative charge in the northern hemisphere, and a positive charge in the southern.



Relation between fall of potential gradient and altitude (Schweidler and Kohlrausch).

This is perhaps not as absurd as it may appear at first sight. Schweidler and Kohlrausch, in the chapter on Atmospheric Electricity in 'Handbuch der Elektrizität und des Magnetismus,' give a curve as in Fig. 1 for the drop of potential gradient with altitude. In the figure the height is given in kilometres parallel to the *y*-axis. With a radial field due to a negative charge on the Earth's surface the curve should have been parallel to the *y*-axis.

In the southern hemisphere Rudge found a positive charge on the Earth's surface at Bloemfontein in South Africa (see *Phil Mag.*, vol. **23** (1912), p. 137 ; also criticism by Karl Bergwitz and Rudge's reply, *Phil. Mag.*, vol. **26** (1913), pp. 376 and 800). Referring to the Earth's "supposed electric charge," Prof. L. A. Bauer writes, "It may be pointed out that the value of the surface density σ of the Earth's assumed negative charge, as deduced from the potential gradient measurements, is subject to a geographical variation of at least 50 per cent.; the average value is -3×10^{-4} E.S.U. At Kew Observatory, England, σ is about three times the average value, and according to the observations made at Sohral, Brazil, by Mr. Andrews Thomson, of the Department of Terrestrial Magnetism, May–June 1919, it is about one-sixth of the average value. When σ is subject to such large geographic variations, the question may be raised whether the surface charge may not at places vanish and at other places have reversed sign, even under normal conditions. It may further be recalled that the measurements of the horizontal electric currents in the Earth's crust, have not yet been brought into harmony, quantitatively, with such horizontal currents as might be indicated by variations in the values of σ."

It is certain the field near the Earth's surface is vitiated by "contact potential" as also by body charges of vapour and dust clouds, and the real cha-

racter of the electric field might be expected to reveal itself at high altitudes. The presence of ions in the atmosphere is an experimental fact. Any electric field would produce a convection current of these ions in their respective directions. If the aurora borealis could be viewed as such electric discharges, their parallelism to the lines of magnetic force would indicate the existence of an electric *dipole* field parallel to the Earth's magnetic field. The auroræ are generally explained as being due to streams of electrons or α particles from the sun. It is however remarkable that both solar "coronal," as well as the terrestrial "auroral" streamers, which are the origins and terminations of the streams, follow the lines of magnetic force when they should move at right angles to them. The agreement of direction of auroral streamers and lines of magnetic force is very close indeed. The difference is hardly more than $1°{\cdot}27$ (L. Vegard, "Results of Northlight Investigations," etc., *Phil. Mag.*, 1921).

Slipher and Lord Rayleigh have found evidence of a permanent aurora, and that at quite low latitudes, by spectrograms. The question naturally arises here as to whether the direction of the auroral streamers is also parallel to the lines of magnetic force or at right angles to them.

For solar coronal streamers "following the magnetic lines of force in the neighbourhood of the equator," see Birkeland's experiments with magnetized-globe cathode (Figs. 247 *a* and 253).

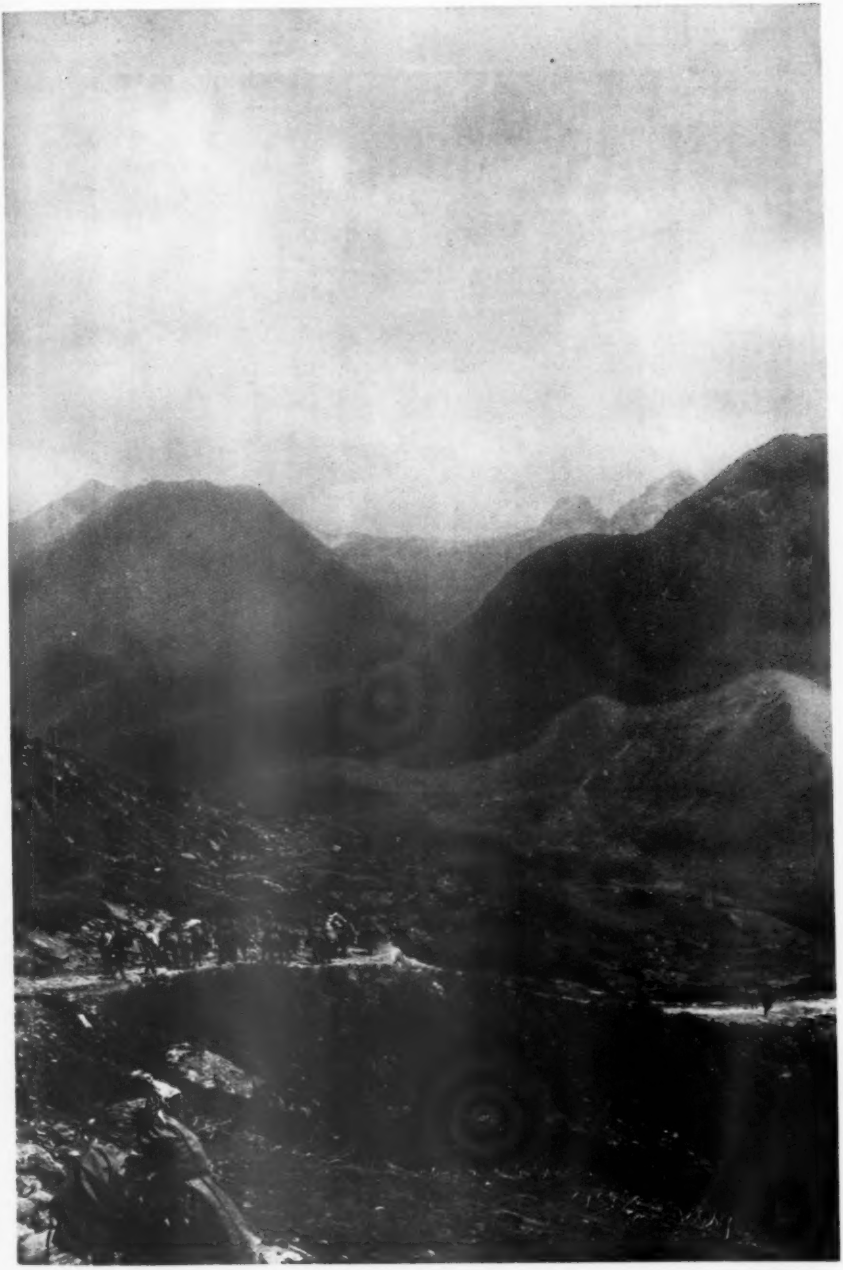
From such evidence the existence of a dipole electric field seems strongly indicated, and Reeves's experiments, repeated at Spitsbergen, Cameroons, Arizona, and other places, may be taken as demonstration of the horizontal component of the Earth's dipole electric field, specially when gravitational and magnetic explanations of the phenomenon have been recognized to be inadequate.

University College, London, 5 July 1922.

PHOTOGRAPHS FROM THE MOUNT EVEREST EXPEDITION

FROM the very large number of excellent negatives sent home by Captain Noel we have selected for reproduction a series which shall illustrate the *route* of this year's expedition without overlapping the photographic results obtained last year by Colonel Howard-Bury and Mr. Wollaston, of which three sets were reproduced in photogravure for the *Journal* of October and December 1921 and February 1922. Reference should be made to the maps published in the latter number, or to the photographic survey of Major Wheeler, of which two sheets have been received, the third, covering the west Rongbuk glacier and the Khombu Pass, being still awaited. Copies of this map may be seen in the Map Room, and a special edition over-printed with a red grid was provided by Colonel Ryder for use in the field this year: without however eliciting a single map reference in report, letter, or list of photographs!

The main body of the expedition was fortunate in finding the Jelap La nearly free of snow so early in the season; but the same heavy snowfall which caught them beyond Phari caught Captain Finch and Mr. Crawford on the pass: and there are in the collection many beautiful pictures of



1. APPROACHING THE JELEP LA

2. SHEKAR MONASTERY FROM THE ROOF OF THE PRINCIPAL TEMPLE

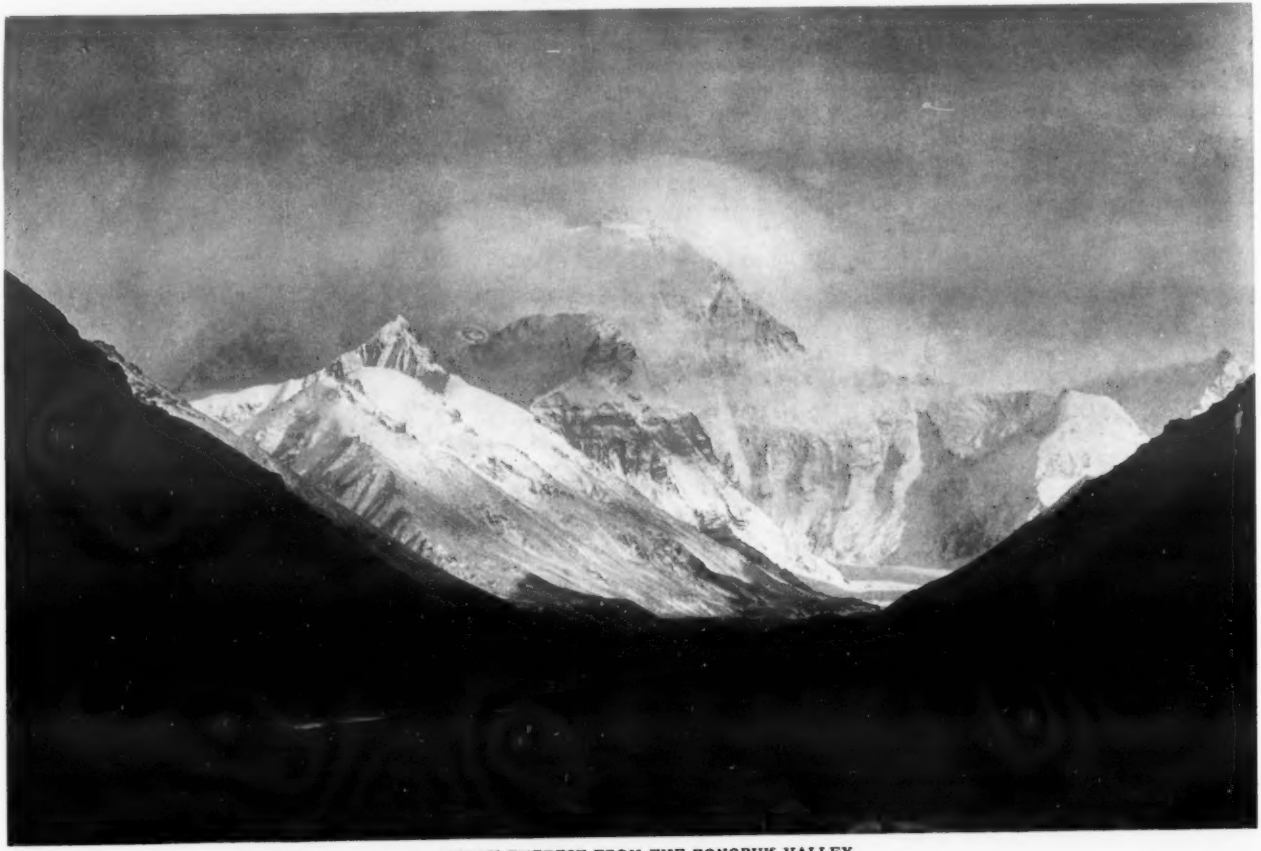
2. SHEKAR MONASTERY FROM THE ROOF OF THE PRINCIPAL TEMPLE

3. MOUNT EVEREST AND THE CHOMO LUNGMA GROUP FROM THE PASS SOUTH OF SHEKAR BETWEEN THE VALLEYS OF THE BHONG ČHU AND THE DZAKAR CHU

4. THE RONGBUK MONASTERY

4. THE RONGBUK MONASTERY

22580 Changtse Mount Everest



5. MOUNT EVEREST FROM THE RONGBUK VALLEY

6. THE BASE CAMP, RONGBUK VALLEY

7. SERAC ON THE EAST RONGBUK GLACIER

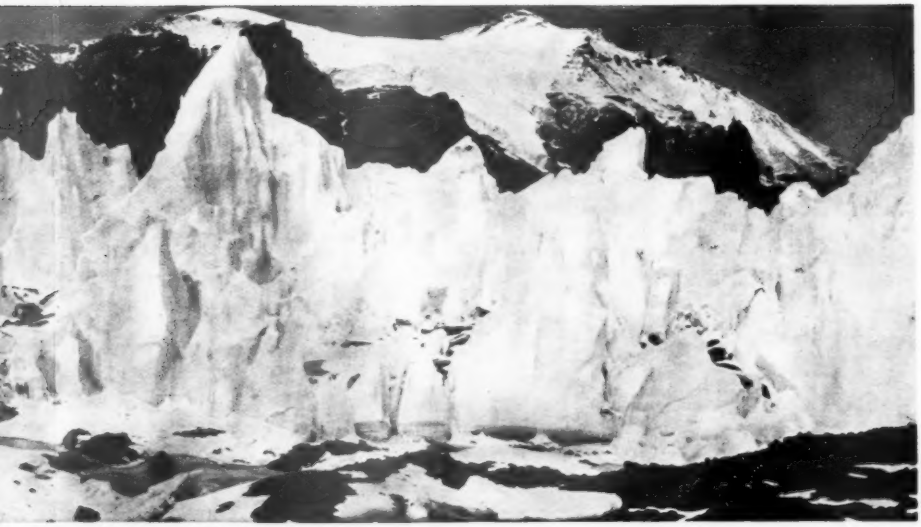
Photo. by Dr. Longstaff

8. EAST RONGBUK GLACIER

Chang La
Camp IV.

Changtse

9. HEAD OF THE EAST RONGBU



UK GLACIER BETWEEN CAMPS II. AND III.

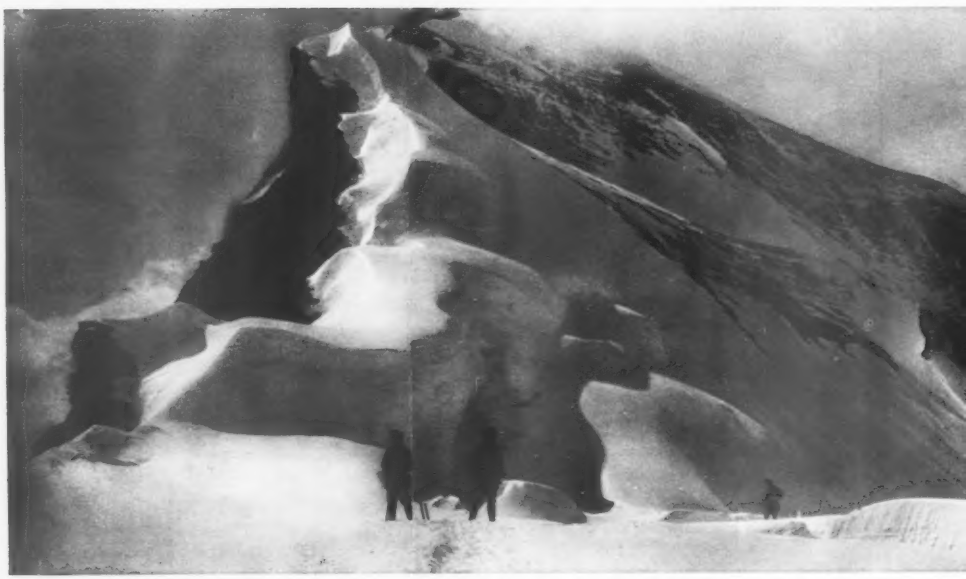
Camp III.

EAST RONGBUK GLACIER AND THE CHANG LA

23180 NORTH 22460 22740

Camp II.

Changtse



22740

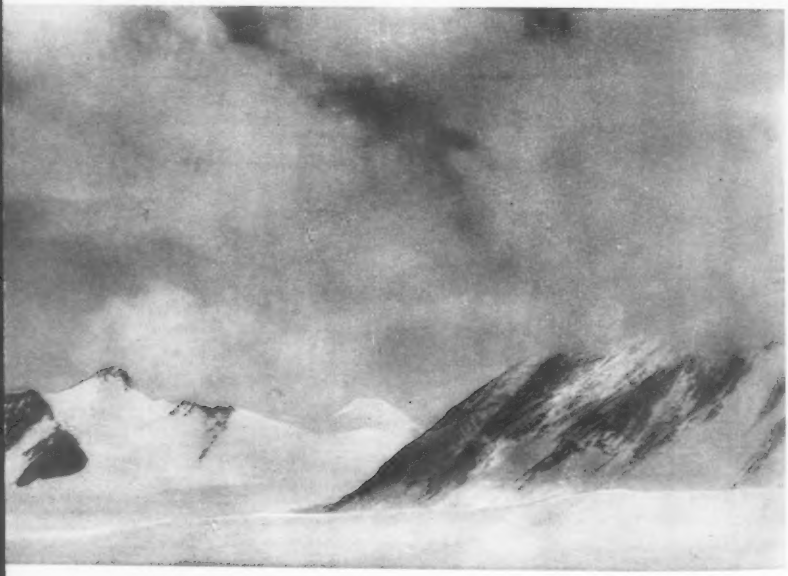
10. THE EAST RONGBUK GLACIER FROM ABOVE CAMP II. (PANORAMA)

11. LOOKING DOWN THE EAST RONGBUK GLACIER FROM THE CHANG LA. Camp III.

rtaphu
3640

Rapiu La

22850



12. SUNSET FROM CAMP II.

14. THE NORTH-EAST SHOULDER AND NORTH ARÊTE FROM CAMP IV.

13. THE APPROACH TO THE CHANG LA

15. THE NORTHERN FACE OF MT. EVEREST (TELEPHOTOGRAPH FROM THE BASE CAMP)

the plains towards Kampa Dzong all snow-covered and exceedingly cold. It is certain that the expedition started this year at the earliest possible date.

They went by Shekar for convenience of transport, and to pay their respects to the Dzongpen in whose district they would be operating; and they obtained a whole series of beautiful pictures of Shekar town, monastery, and fort—enough to illustrate and to provide a monograph on Tibetan architecture. From Shekar they travelled almost due south across the Bhong Chu (Arun river), and so by a pass, which is not named on Major Morshead's map, from which there was a comprehensive view of Mount Everest and the Chomo Lungma group (Plate 3). This is an aspect different from anything that was obtained last year, and the picture will repay careful study and measurement, as soon as we can obtain from Captain Noel the focal length with which it was taken. The deep valley in the foreground is that of the Dzakar Chu about Namda. Here the expedition turned a little westward and reached the Rongbuk valley by a way somewhere in the right of the picture. The valley in the middle distance, below the first snows, is that leading to the Doya La by which one gets to Kharta. We are looking from a little east of north; the main Rongbuk valley runs rather west of north, and so is not clearly seen in this picture.

Plate 4 shows the Rongbuk monastery, well up the valley, and only a few miles below the snout of the main glacier. Last year this monastery, curiously enough, was little mentioned and not photographed, and we were hardly prepared for the considerable part it has played in this year's expedition. The chief Lama received the General and his party with great ceremony, realized that it was the sacred duty of this Society and the Alpine Club to visit the most celebrated mountain, and gave his blessing to the porters and coolies. The friendly relations and sympathetic interest thus established were of the greatest importance to this year's and to any future expedition, for it was a veritable invasion of the usually silent, bare, and by nature inhospitable valley, without supplies, without fuel, and remote from the passes into Nepal by which Kharta and the Kama valley can be supplied.

The main camp was pitched a little above the monastery and below the glacier moraine, in the foreground of picture 5, which shows the entrance to the East Rongbuk valley just beyond the dark hill on the left, and in front of peak 22,580. Camp I. was established just round the corner here, on the left bank of the tributary stream, and above this camp began the struggle with the excessively awkward East Rongbuk glacier. The only knowledge we had last year of this glacier was derived from Major Wheeler's photographs and account: and there was little in these to prepare one for the fantastic scenes about Camp II., shown in pictures 7, 8, 10, and 12. The tributary glacier coming down from peak 22,580 (Plate 12) is bordered by an ice-cliff near 100 feet high: the

15. THE NORTHERN FACE OF MT. EVEREST (TELEPHOTOGRAPH FROM THE BASE CAMP)

seracs on the main glacier are of the same order of height, as may be seen on comparison with the small figure shown in Plate 7. And from the slight accounts we have of the last days on the glacier, when the camps were being evacuated after the monsoon had broken, it would seem that this fantastic ice structure alters very rapidly each summer. What a field it would be for stereographic survey of glacier movement!

The small party who came last year to the head of this glacier from the Kharta valley over the Lhakpa La, missed all the exciting stage between Camps II. and III., and encountered only the relatively easy surfaces shown in Plates 9 and 11, up to the foot of the Chang La. They made no special reference to difficulties in the ascent, and took no photographs from close at hand: also they were dealing with much deeper snow, after the monsoon. Plates 9 and 13 show that the route is formidable, beset with crevasses and ice-cliffs on a scale which seems at first sight out of proportion to the relatively small catchment area and the very thin covering of the mountain. For the mountain before the monsoon is mostly bare rock (Plates 14 and 15), but the dip of the strata is toward the north, and the slabs are therefore tilted in such a way that they are very dangerous when thinly covered with snow.

The last picture (No. 15) is one of a pair taken near the base camp with a telephoto lens, on a base of about 160 yards. The pair give an excellent stereoscopic combination, bringing out the structure of the northern face excellently, though it is about 12 miles away. The pictures can be seen in the stereoscope in the Society's Map Room. In examining these photographs one must remember that the telephoto lens often gives curious perspectives: see, for example, Plate 12 in the February *Journal*, where the walls of the great cirque seem to be flattened up against the north-east shoulder of the mountain; also that the camera was a good deal tilted up, so that, although the picture was taken from 16,500 feet, the spectator seems to be nearly level with the summit of Changtse (24,730), which, it should be noted, is not the point at the end of the long ridge leading away from the camera, but is the rounded dome further back and to the left, or perhaps even beyond this. The first climb reached a point about 450 feet below the north-east shoulder; the second, by a long traverse across the north face, reached about the snow-patch to the left of the big black mark, just over Changtse.

True heights by aneroid have been checked by theodolite observations (incomplete owing to persistent bad weather) made by Major Norton and computed by Major Morshead. They confirm very well the aneroid heights for Finch and Bruce, and suggest that the Mallory party went somewhat higher than they estimated, very nearly 27,000 feet. We hope to publish later a full discussion of the height determinations, when all the details have been received from India.

Major Norton has returned in good health, but has lost by frostbite a small piece of his right ear. Major Morshead writes that his frostbitten

hand is doing better than was expected, and he may lose only one finger-tip. Dr. Wakefield will be home before the end of September, and General Bruce early in October. Captain Noel is expected in London the day before the joint meeting at the Central Hall on October 16, at which all the members of the expedition who went out from England will be present except perhaps Mr. Somervell.

The greater part of the collections have now been received. About 400 specimens of pressed flowers have been sent to Kew for identification, and the roots of two different primulas which it is hoped may have survived the journey. A small collection of insects and reptiles, and a few birds and mammals, are being examined at the Natural History Museum. The geological specimens, after examination by Dr. Heron, are on their way home. We understand that Mr. Somervell has made a large number of sketches, and has also recorded the music of many Tibetan songs. Captain Noel, when he wrote last from Gyantse, had obtained excellent films of Tibetan life and of Lama ceremonial.

General Bruce has reported to the Mount Everest Committee that suitable provision has been made for the families of the seven Nepalese porters unhappily lost in the third attempt. The Commissioner at Darjeeling has very kindly undertaken the monthly payment of the allowances, on behalf of the Committee.

THE INTERNATIONAL GEOGRAPHICAL UNION

AT a Conference held in London in October 1918, between representatives of the Academies of Science of the principal Allied Powers, it was resolved that the nations at war with the Central Powers should as soon as possible denounce the conventions governing International Scientific Associations, and should form new scientific associations for international co-operation, with the eventual concurrence of the Neutral Powers. To this end an International Research Council was organized at Brussels in 1919 by representatives of the Principal Allied and Associated Powers, and to this Council the neutral nations, Spain, Holland, Sweden, Norway, Denmark, and Switzerland have since adhered.

A principal object of the International Research Council is to promote the formation of International Unions in the different sciences or groups of sciences. When a new Union is proposed, the first step is to form in each country a National Committee for that science, under the auspices of the National Academy of the country. When, therefore, it was proposed by certain French and Belgian delegates to the first General Assembly of the Council that an International Geographical Union should be formed, the Royal Society consulted the Conjoint Board of Scientific Societies, and on its recommendation constituted a National Committee

for Geography, comprising two representatives of the Royal Society, three of the Royal Geographical Society, one each of the Royal Society of Edinburgh, the Royal Irish Academy, the Royal Scottish Geographical Society, and the Geographical Association, with the Hydrographer of the Navy, the Director-General of the Ordnance Survey, and the President of Section E of the British Association as ex-officio members.

This Committee, meeting in 1921 under the chairmanship of Sir Charles Close, resolved to recommend to the Royal Society that Great Britain should join in the proposed formation of an International Geographical Union, and that delegates to the next meeting of the Research Council should be nominated to this end. Having carefully considered a draft of proposed statutes, following closely those already adopted for the Union of Geodesy and Geophysics, the British National Committee resolved to suggest a simplification by omitting the division into six or more sections, each with its own President, Secretary, and organization. This suggestion was submitted to the French National Committee for consideration.

The second General Assembly of the International Research Council was held in the Palais des Académies at Brussels on July 25–29. Its agenda included the question of the formation of an International Geographical Union: the Royal Society had therefore nominated among the British delegates Sir Charles Close, Colonel H. G. Lyons, and Mr. Hinks. French geographers were very strongly represented by Prince Bonaparte, General Bourgeois, M. Cordier, M. Lallemand, Colonel Bellot, Professor de Martonne, M. Grandidier, and Colonel Perrier; Belgium by Colonel Seligman, Professor Hegenscheidt, and M. Kraenzel; Italy by General Vacchelli and Professor Magrini; Japan by Professor Yamasaki and Dr. Nakamura; Spain by General Nuñez Gomez, Professor De Buen, and Señor Mereguor; Portugal by Admiral Nouparth; and Poland by Professor Szajnecha.

A little preliminary discussion during the first two days of the Assembly prepared the way for a very harmonious meeting of the geographical delegates on July 27, with Professor Hegenscheidt in the chair. The Statutes as redrafted by the Presidents of the several National Committees were agreed without dissent. Prince Bonaparte was chosen unanimously the first President of the International Union of Geography, and Sir Charles Close the General Secretary. The formation of the Union and the adopted Statutes were reported to the final meeting of the General Assembly of the Research Council on July 29, and will be submitted for confirmation to the National Academies of the constituent countries, which will be invited to adhere to the new Union.

The Statutes thus submitted for confirmation necessarily conform in principle to those of the International Research Council. The General Assembly of the Union is formed of delegates nominated by the National Committees, which are charged with the study of geographical questions

in their international relations. A question to be considered by the Union must be submitted in advance by a National Committee. Any member of a National Committee may attend the General Assembly and speak; further, the President may invite scientific men of any adhering country to attend the meetings of the Assembly in a consultative capacity. But on all administrative questions—and these are really the only questions upon which a vote is possible—the vote is cast by countries, and is weighted according to a scale depending on the population of the country. This requires that the voting powers of any country shall be entrusted to one of its delegates—as in the Assemblies of the International Research Council—and the method has the considerable advantage that it will compel each group of national delegates to prepare for the meeting by a preliminary settlement of any internal disagreements, so that at the General Assembly they can support the national vote on a united front.

The Executive Committee of the Union shall, it is proposed, consist of the President, the General Secretary, and not more than six Vice-Presidents. It was agreed to recommend that General Vacchelli (Italy) should be the First Vice-President, and that three of the remaining five places should be filled by Professor Yamasaki (Japan), General Nuñez Gomez (Spain), and Commandant De Gerlache (Belgium).

The funds of the Union will be derived from the annual contributions of adhering countries on a unit of 500 francs (French currency), and the number of units payable by any country depends on its population, according to the scale adopted by the Research Council, with a maximum of eight units. These funds will be devoted to the expenses of administration, the cost of publications made under the direction of the Union, and ultimately to the cost of special researches undertaken by it. The British Government has placed in the hands of the Royal Society an annual sum for the payment of the national contributions to International Unions.

The General Assemblies of the International Union of Geography will be held every three years. Their principal end will be to promote and co-ordinate researches requiring the co-operation of several countries; to ensure their scientific discussion and publication; and to organize International Congresses of Geographers.

The International Union of Geography being thus in a fair way to foundation, it is necessary to consider what it may usefully do. The proposed Congresses will presumably coincide with the meetings of the General Assembly: they will serve the excellent purpose of bringing together for mutual acquaintance the geographers of adhering countries; their meetings will provide opportunity for discussion of questions not formally brought before the General Assembly. But it seems that the Assembly will constitute a more formal, a more authoritative, inner body

representative of the considered opinions of the National Committees, and able to give them effect because it will control funds of some importance. The executive committee will ensure continuity of effort; and the new organization will have much more power of effective work than the old type of International Conference, that was not really representative, and could do little more than promote acquaintance, air opinions, and pass resolutions that bound no one in particular.

In the present condition of the world the cost of international meetings must be reduced to a minimum, and it is particularly desirable that no special expense should fall upon the country that is chosen to be the seat of a General Assembly. It might be well that each International Union should make it clear from the beginning that it does not expect to be entertained; that it would prefer to meet rather informally in a place chosen for interest and convenience, preferably not a capital city where hotels are expensive; that it is prepared to pay from its corporate funds for the hire of the necessary meeting-rooms, say in a smaller University city; and that nothing more is expected of any national or local committee than that it shall assist the delegates to find convenient, modest accommodation, each at his own expense. If this were once thoroughly understood, it would be possible for the International Geographical Union to meet in smaller, less well known, and geographically more interesting places than any which could be expected to invite an Assembly. A. R. H.

DOLOMIEU AND DE SAUSSURE

Déodat Dolomieu Membre de l'Institut National (1750–1801): Sa correspondance, sa vie aventureuse, sa captivité, ses œuvres. Tomes 1, 2. Par A. Lacroix. Librairie Académique Perrin et Cie. Paris, 1921.

THE biographical material ready for use in recording the lives of the two leading Alpine geologists of the eighteenth century, after lying neglected for a hundred and twenty years, has by a curious coincidence been taken seriously in hand almost simultaneously in this country and in France. Two years ago my volume on de Saussure was published. Twelve months later the Secrétaire perpetuel de l'Académie des Sciences de France has brought out two volumes dealing with de Saussure's attached friend and follower, Dolomieu.

Monsieur Lacroix has not thought fit to weld his abundant material into the form of a biography. He has preferred to furnish brief outlines of his subject's romantic career and scientific activity as an introduction to copious extracts from his journals and his correspondence. His task must have involved much research, since the letters were widely scattered. It has been executed with great thoroughness, and the documents are annotated throughout with the precision we look for in such a quarter. The few printer's slips we have noticed, beyond the list of "errata," are not worth mention.

The life of—to give him his full name—Dieudonné-Sylvain-Guy-Tancrède dit Déodat, de Gratet, de Dolomieu was far from being the tranquil existence

generally associated with geological pursuits. Born of noble parents at Dolomieu near La-Tour-du-Pin in Dauphiné, the child at the age of twelve was entered on the roll of the Knights of Malta. At eighteen, having unfortunately killed his adversary in a duel, he was expelled the Order and for a time imprisoned. At twenty-one we learn from his letters that he was in garrison at Metz, and showing a disposition for natural studies not unrelieved by love-affairs. At this period he made the acquaintance of the accomplished Duc de la Rochefoucauld, who encouraged his scientific tastes, and at La Roche-Guyon introduced him to some of the leading spirits of the time. Dolomieu now became a Correspondent of the Académie Royale des Sciences, and for some years travelled and observed widely in Italy, Sicily, Tyrol, and the Pyrenees. At a later date we find him back at Malta and holding high administrative office there, which he threw up in consequence of a quarrel with the heads of the Order. On finally quitting Malta in 1790 he planned to present his fine geological cabinet to the Congress of the United States! This proposal, which he failed to carry out, was a notable indication of a change in Dolomieu's political opinions. The aristocrat had become a Republican. But the march of events at Paris soon outstripped his enthusiasm.

In 1792 Dolomieu had the misfortune of seeing his patron the Duc de la Rochefoucauld murdered "under his eyes, almost in his arms." In 1796 we find him established at Paris as a Government official in the École des Mines. Two years later this fair prospect of calm and practical scientific work was cut short by Berthollet's proposal that he should form one of the party of savants taken by Napoleon to Egypt. Shipwrecked at Taranto on his return, he was cast into prison at Palermo by the Neapolitan authorities. There, writes Monsieur Lacroix, Dolomieu was "stripped of his possessions and shut in a dungeon with little light or ventilation, in which for twenty-one months he suffered every hardship at the hands of a barbarous gaoler." His position attracted universal sympathy even among his country's enemies. Sir Joseph Banks, who throughout the war did his best to keep up good relations throughout the scientific world, intervened warmly on Dolomieu's behalf. At Naples Sir William Hamilton and Nelson pleaded for his release, which was in the end granted. His return to Paris was a triumph. Having taken up his work and lectures at the École des Mines, he set out to visit his family in the provinces. But his health was broken by his hardships, and he died at the age of fifty-one while preparing for a visit to the celebrated geologist Werner in Saxony.

The branch of geology to which Dolomieu mainly devoted himself was the study of volcanoes and earthquakes. He sided strongly with the Vulcanists against Werner and the Neptunians, who denied the volcanic origin of basalt. In Calabria and Sicily he found a field for seismical observations in which he showed that the extent of devastation depended largely on the character of the soil, alluvial deposits being far more sensitive to the vibrations than solid rocks. Unlike in this de Saussure, he had a strong taste for antiques, and investigated the marbles employed by the Romans with the object of tracing the country of their origin, a study which, carried out in our own day, has led to the rediscovery of many ancient quarries in North Africa and Asia Minor.

On the Alps Dolomieu described himself as the disciple of de Saussure. He had already grasped the notion of crustal displacements expressed in the modern doctrine of overthrusts (*charriages*), and maintained that the primitive rocks had been, at any rate on the northern slope, largely covered by a mantle of secondary strata. Of his travels in the Alps we have, it seems, little record, but his reference to the ascent of the Buet as one "which caused him no fatigue" shows that he was at any rate a better mountaineer than Bourrit!

The correspondence printed here contains many interesting references to the contemporary group of Genevese savants, and throws fresh light on Dolomieu's relations with de Saussure and other geologists of the period—Desmarets, Guettard, and Faujas de Saint-Fond. While in prison he passed the time in writing short characters of his friends. Of de Saussure he writes, "L'opinion publique, sûrement d'accord en ce point avec le jugement de la postérité, a fixée la place de cet homme illustre parmi les premiers physiciens du siècle et à la tête des géologues."

On one point of interest to modern travellers more exact light is here thrown. We learn how Dolomieu's name came to be affixed to the magnesian limestone peaks of Southern Tyrol. Dolomieu had sent a specimen of the rock to Nicolas Théodore, de Saussure's son, to be analysed. When Théodore wrote to Dolomieu asking him what name he suggested for the new rock, the latter replied that, had he thought his discovery of sufficient importance, he would have liked to name it after de Saussure, but that he refrained from a feeling that the compliment would not be worthy of its object. Thereon Théodore, I venture to think acting not without his father's knowledge, described it in a contribution to the *Journal de Physique* (vol. 40, p. 167) under the name of "dolomite," which it has ever since retained.

Dolomieu's letters convey the impression of a man of a liberal mind, wide-spreading interests, and a generous heart. Here are his reflections at the age of forty-six on the future of geology. After congratulating himself on an interval of repose in his own home in Dauphiné, he goes on:

"Cette génération qui me répousse dans la nuit des temps fera plus que l'age où nous avons vécu n'a pu faire, parce qu'elle a pour avance tous les matériaux que nous lui avons fournis, et nous pouvons présager sans jalousie tous les succès qu'elle obtiendra dans la carrière où nous l'avons précédée. Ainsi l'illustre Saussure sorti maintenant de la lice, où il a acquis tant de gloire, peut prévoir qu'après avoir fixé l'attention des naturalistes sur une infinité d'objets qui n'ont pu être suffisamment éclairés par ses observations, ils découvriront nombre de vérités qui lui sont restées inconnues et il pourra jouir sans envie des travaux des naturalistes qui, marchant d'abord sur ses traces, finiront par le devancer."

In October 1801, after de Saussure's death, Dolomieu writes to M. P. Picot: "Je suis extrêmement touché, mon ami, de ce que vous me dites sur Mme. de Saussure. Je conserve pour cette respectable femme l'attachement et la vénération que j'avais pour son mari, et je ne pense jamais à l'un des deux sans me rappeler de l'autre, parce que je sais qu'ils étaient inséparables, qu'ils partagaient et leurs peines et leurs plaisirs, et que, si l'un appellait la gloire et la considération autour de leur famille, l'autre y établissait le bonheur. La conduite de Mme. de Saussure est admirable: elle doit lui fournir un grand sujet de consolation pour la perte qu'elle a éprouvée; celui d'avoir rempli auprès de celui qu'elle regrette tous les devoirs d'une bonne épouse et d'une tendre amie; d'avoir adouci le plus possible tous ses maux et d'avoir su rendre moins pénibles ses derniers instants."

In the same letter, written only a week before his own death, Dolomieu excuses his reluctance to undertake a biography of his friend: "Je ne doute pas que l'éloge de M. de Saussure ne soit fait un jour par quelque naturaliste, qui, pénétré de reconnaisance pour les progrès qu'il a fait faire à la science dans ses différentes branches, et étonné de sa persévérance dans la recherche de la vérité, de son extrême exactitude dans ses observations, de sa sagacité pour en découvrir les conséquences nécessaires et de sa circomspection pour leur

appliquer des théories hypothétiques ; je ne doute pas, dis je, qu'un naturaliste plein de son sujet ne fasse de M. de Saussure un éloge historique animé par plus de chaleur et plus de sentiment que n'en a su mettre M. Senebier . . . L'amitié dont M. de Saussure m'honorait, mes sentiments pour lui, l'avantage de connaître peut-être mieux que tout autre et le mérite de ses recherches et les difficultés de ses travaux et l'importance de leurs résultats, m'auraient imposé le devoir de rendre à sa mémoire le tribu d'éloges qu'elle mérite, mais mon imagination n'est plus au niveau d'un pareil sujet, mon talent ne serait point en rapport avec mes sentiments ; je dois me borner à défendre les opinions de ce célèbre géologue, à préserver sa gloire des atteintes qu'on voudrait lui porter, à présenter son exemple comme objet d'émulation et d'encouragement à ceux qui voudront suivre la même carrière, et à puiser dans ses ouvrages des autorités pour toutes théories raisonnables, et des faits à opposer aux écarts de l'imagination de ceux qui ne savent ni bien observer ni profiter des observations faites par d'autres."

This forcible expression of Dolomieu's scruples cannot but give ground for anxiety to one who with far fewer qualifications has ventured to attempt the task he shrank from. It is, however, a satisfaction to me to find that M. Lacroix's volumes confirm in all essentials my estimates of the characters on the Genevese scene at the close of the eighteenth century and call for few corrections in my pages. I may in conclusion note one that has a certain interest. I accepted the report current at the time that the Royal Society had officially intervened to obtain Dolomieu's release from his Sicilian prison. M. Lacroix prints a letter from Sir Joseph Banks to Dolomieu in which he informs him that the steps he had taken in his favour had been made as an individual and *not* as President of the Royal Society. Sir Joseph Banks somewhat pompously declares, "We in England, sir, are as firmly attached to Royal Government as you can be to Republican, and, whatever our private wishes might be, we did not think it proper or decent to speculate on the conduct of a king whose motives we could not be acquainted with, or as a public body to take matters of a political nature in any shape under our consideration."

A pleasing portrait of Dolomieu at the age of forty by Angelica Kauffmann serves as frontispiece to M. Lacroix's work. D. W. F.

TWO NEW MAP PROJECTIONS

Note on Two Double, or Two-point, Map Projections.— Colonel Sir Charles Close, K.B.E., C.B., C.M.G., F.R.S., Director-General of the Ordnance Survey. Professional Papers, Ordnance Survey, New Series, No. 5. H.M. Stationery Office. 1922. Pp. 8, with five plates. *1s. 6d. net.*

TO indicate the nature of these two new projections we cannot do better than repeat Sir Charles Close's short preface to his paper : "The two projections briefly described in this paper are derived from a consideration of the Zenithal group of map projections. Of this group the simplest is that known as the Zenithal Equidistant Projection, in which some one point is chosen as the centre of the map, and from this point radiating straight lines represent great circles, inclined at their true azimuths, and are plotted true to scale. We have thus, in this projection, two properties concentrated, as it were, at *one* point : namely, correct representation of azimuths at the point,

and correct representation of distances along the straight lines radiating from this point.

"Now it is possible to choose one of these properties and apply it to *two points*. Thus we can select two points, and devise projections in which (1) the great circles shall be represented as straight lines radiating at their true azimuths from each point; or (2) the distances from these two points to all other points shall be true to scale; or (3) from one point the distances, and at the other point the azimuths, shall be correct. This paper deals with (1) and (2). The projections in question may, perhaps, be called Double or Two-point Projections."

Its inventor gave a short description of the second of these projections, the Double Equidistant, in the *Geographical Journal* for June 1921, in the first of "Four Notes on Map Projections." Practical use might be made of such a projection in navigation, say by a ship trading continuously between the same two ports, for if these two ports were chosen as the ends of the base of the projection, the chart would give by direct measurement the distance of the ship from each port. By choosing the Pole as one end of the base and any fixed point on the Earth as the other, the projection can also be used for the graphical solution of the "astronomical triangle."

Sir Charles Close seems to have been quite naturally led on from the Double Equidistant to a consideration of the first projection described in this paper, which he calls the Double, or Two-point, Azimuthal. He points out that practical use could be made of this projection in navigation by a ship receiving its true bearings by wireless waves from two fixed stations. He noted that the projection in question appeared to be allied to the ordinary Gnomonic, as in every case several systems of great circles are in it represented by straight lines. Just before his paper was published his attention was drawn to an article by Prof. H. Maurer in the *Zeitschrift für Vermessungswesen* for 1 January 1922, in which the same projection is discussed and in which its exact relation to the ordinary Gnomonic is shown. This paper also refers to previous work on the projection by Klingatch (1921), Wedemeyer (1919), Immler (1919), and Thorade (1919). Attention seems to have been drawn to it in Germany and Austria during the War from the desire to find a projection which would be suitable for plotting positions from directions of wireless waves. Although this country cannot claim priority for the Double Azimuthal, it is only right to mention that the *possibility* of such a projection was mentioned by Mr. J. I. Craig, of the Survey Department of Egypt, at page 5 of his valuable work on 'The Theory of Map Projections,' published in Cairo in 1910.

We have also had the privilege of seeing a paper prepared by Captain G. T. McCaw, Geographical Section, General Staff, in which the properties of the Double Azimuthal Projection, including the differential scale errors and certain finite errors, are very fully investigated, for the use of the War Office and allied departments. Its connection with the true Gnomonic Projection may be briefly described as follows: Suppose A and B are the two fixed points from which it is desired that the directions on the map should be true, and that $2b$ is the distance between A and B. Taking O the middle point of AB as origin, calculate the rectangular coordinates parallel and perpendicular to the line AB for a Gnomonic Projection with O as centre. Multiply all the coordinates parallel to AB by cos b, where the distance b has been converted into the corresponding spherical angle. Then the resulting projection will be the Double Azimuthal, or Orthodromic, as it has been called by Prof. Maurer. This will not be precisely the projection as described by Sir Charles Close, for in

the latter the projection of AB is true, whereas in the Gnomonic it would be greater in the ratio tan b/b. To produce Close's projection we require further to multiply both sets of coordinates by b sin b, or, starting with the original Gnomonic, we get Close's projection by multiplying the coordinates parallel to AB by b cot $b = 1 - \frac{1}{3}b^2 - \ldots$, and those perpendicular to AB by b sin $b = 1 + \frac{1}{6}b^2 + \ldots$ It is obvious, however, that once having multiplied the coordinates parallel to AB by cos b, we might further multiply both sets by any suitable scale constant. Captain McCaw advocates the further scale constant of $1 - \frac{1}{2}b^2$, which has the effect of making the scales at A and B true, and the projection orthomorphic at those points. The average scale error would be made a minimum over a map of a diameter equal to AB by using such a scale-constant as would make the total area true. This scale-constant would be $1 - \frac{1}{6}b^2$, that is, $1 - \frac{2}{3}b^2$ to make the total area of the Gnomonic true, and then $1 + \frac{1}{4}b^2$ to correct the diminution of area caused by reducing the coordinates parallel to AB by cos b.

Generally speaking, the errors of the Double Azimuthal Projection are a little greater than those of the original Gnomonic. The principal axes, along which the greatest and least scale errors at any point P lie, bisect internally and externally the angle APB. In the Gnomonic of course they lie along and perpendicular to the ray OP.

The fact that the Double Azimuthal Projection is connected so simply with the Gnomonic caused us to suspect that the Double Equidistant might be connected in a similar way with the ordinary Equidistant. On examination it appears to be so, at any rate as far as quantities of the second order in the expansion of the scale errors, that is, as far as Legendre's Theorem is legitimate in calculating spherical triangles. It appears, then, that having calculated the coordinates from O as origin parallel and perpendicular to AB as for the ordinary Equidistant, we shall arrive at sensibly the coordinates for the Double Equidistant by using the parallel coordinates as they stand, but by first multiplying the perpendicular coordinates by $1 - \frac{1}{6}b^2$. Again, any suitable scale constant could be applied to both coordinates, *e.g.* to make the average scale error a minimum, $1 - \frac{1}{24}b^2$ for the Equidistant and $1 + \frac{1}{12}b^2$ to correct the effect of $1 - \frac{1}{6}b^2$, that is, $1 + \frac{1}{24}b^2$ applied to both sets of coordinates. In the Double Equidistant also the principal axes bisect internally and externally the angle APB, and the scale errors are, generally speaking, a little greater than in the ordinary Equidistant.

The fact that new and practically useful map projections have been obtained by what may be described as orthographic projections, parallel to a certain axis, of two well-known projections opens a new vista of research in this interesting subject, as it is possible that the extension of the principle of perspective projections of other already known projections may lead to further results of interest and practical utility. A. E. YOUNG.

REVIEWS

EUROPE

L'Industrie du Fer en France.— J. Levainville. Paris: Armand Colin. 1922. Pp. 211. *Four Sketch-maps. Price 5 frs.*

THIS little book gives an interesting account of the iron industry of France. It is mainly historical and general in scope, avoiding the description of technical details relating to the metallurgy of iron and steel, and dealing rather with the commercial and economic aspects of the industry.

There are four chapters, the first of which gives a brief account of the iron ores of Lorraine, Normandy, Brittany and Anjou, the Pyrenees area, Tunisia, and Algeria. Chapter ii deals with the early evolution of the industry from the Bronze Age to the end of the eighteenth century, during which time the making of iron was dependent on the use of wood charcoal. The Romans, who found iron-ore mining and smelting going on in France, introduced the Catalan forge, the use of which persisted up to the end of the thirteenth century. About that time the use of furnaces of larger capacity spread to France from Central Europe, and had completely supplanted the smaller portable furnaces early in the sixteenth century. These larger furnaces required water-power for the operation of bellows and hammers, and ironworks thus came to be localized in vicinities where water-power was available, generally in the upper reaches of river valleys. Under these circumstances it was economical to take the iron ore or the charcoal or both to districts such as Dauphiné and Foix, where the rainfall maintained a supply of water-power throughout the year. Chapter iii deals with the conditions accompanying iron production by means of coke in the nineteenth century, when proximity to coalfields and transport facilities, including canals, became of paramount importance in the development of the industry. In Chapter iv the effect of the war on the iron industry of France is outlined.

While showing the strong position France has gained in the world's iron industry by the recovery of Lorraine, M. Levainville emphasizes the seriousness of the difficulty that country has to face through deficient supplies of good coking-coal, so important for blast-furnace requirements. In giving prominence to the French reserves of iron ore as compared with those of other countries, he, not alone among French authors, seems not to have studied carefully the position of Great Britain, whose reserves are far in excess of the amounts he mentions, and whose imports of iron ore are to be regarded as a matter of commercial convenience rather than one of strict necessity.

The book contains four useful sketch-maps, inserted at appropriate places in the text, showing the distribution of iron ore, coal, blast-furnaces, and steel-works in France. T. C.

AFRICA

Ergebnisse der Forschungen am Kilimanjaro, 1912.— Dr. E. Klute. Berlin: Dietrich Reimer A. G. 1920. Pp. viii. and 136. *Illustrations and Map. Price* 14 *marks.*

This small volume contains the results of a detailed scientific and topographic survey for the purposes of which the author, assisted by E. Oehler, spent six months of 1912 on the upper slopes of Kilimanjaro. The two mountaineers reached the, till then, unconquered summit of Mavenzi and ascended Kibo, for the first time over its western glaciers. Based on and, to a large extent, rectifying the observations and conclusions of H. Meyer's, C. Uhlig's, and F. Jaeger's expeditions, the book forms a most useful summary of our present knowledge of Africa's highest mountain. It is to be regretted, however, that motives of economy have led Dr. Klute to condense to a somewhat excessive degree, and have made it necessary to postpone a description of the topographic work and the methods employed. Without this information it is almost impossible to gauge the accuracy of the map which accompanies the book.

But whatever the degree of accuracy attained, the map of upper Kilimanjaro in 1/50,000 with 50-metre contours is the outstanding feature of the work, and

its authors are to be congratulated on the successful accomplishment of a task which must have severely taxed their power of endurance. A map the greater part of which is based on a stereophotogrammetric survey is a vast improvement on Dr. Meyer's early representation (1/100,000), and also, to a certain extent, on Dr. Jaeger's map (1/40,000) of western Kibo. On the other hand it is remarkable to find, on comparison, how well, on the whole, the first explorer had grasped the main topographic characteristics of the mountain. The only noteworthy exception is that of Shira Ridge, the bent form of which, as revealed by the stereophotogrammetric survey, leaves no doubt that it represents the remains of the southern and western wall of a former very large crater.

Much of the book is taken up with the meteorology of the mountain and the surrounding country, to the knowledge of which continuous observations during four months at altitudes of 2750 and 4160 metres have added considerably. The fact that the upper mountain reaches well into the zone of the anti-trade has been firmly established (p. 42).

The chapters on rocks and vegetation are merely short summaries, the remainder of the text being taken up by discussions on the geological structure, morphology, and glaciation. Naturally a good many of the earlier conceptions and theories have had to be revised in the light of new and more accurate observations. Thus Dr. Klute sees reason to explain the great western barranco of Kibo and the two Mavenzi barrancos as due solely to erosive forces, thus denying the tectonic and explosive theories of Meyer and Jaeger. The staggered superposition of lava-flows from Kibo and Mavenzi on the plateau between the two peaks leads the author to assume that the final periods of activity of both volcanoes were simultaneous (p. 132), which does not, however, exclude the hypothesis that the first Kibo eruptions started later than those of Mavenzi. An instructive schematical sketch on p. 61 explains the author's conception of the mountain's structure.

His remarks on the extent and character of the present glaciation and its recent fluctuations agree, on the whole, with Jaeger's conclusions. The type of "glacier-cap" introduced by Jaeger is confirmed. Measurements of its movement on one of the largest western glaciers, extending over thirty days, give a mean velocity of 7 metres.

Much less secure ground is, however, entered where the attempt begins to fix the limits of maximum glaciation during the pluvio-glacial period. It seems to be Dr. Klute's tendency to fix these limits everywhere on the mountain even below those originally given by Meyer, thus differing widely from Uhlig and Jaeger, who, at least on the south-east, east, and north-east slopes of Kibo, place the line of lowest glaciation much higher. From my own observations I feel inclined to agree with Jaeger rather than with Dr. Klute. From what I have seen there is nothing to prove a former glaciation of the plateau between the two peaks which could not equally well be explained by long-continued weathering and by ordinary fluviatile erosion and deposition. Neither have I noticed the two large lateral moraines which are shown on Dr. Klute's map as running south from the "Eastern and Western Lava-Hills," down to 4100 metres.

The author's very interesting conclusions from the extent—as traced by him—of quaternary glaciation lead him to favour cosmic rather than terrestrial causes for the ice age (pp. 125–6). C. GILLMAN.

The New Zambesi Trail.— C. W. Mackintosh. London: T. Fisher Unwin. 1922. Pp. 370. *Illustrations and Sketch-maps.* 10*s.* 6*d. net.*

In 1903 the author of this book accompanied François Coillard, whose Life she subsequently wrote, on his last journey to the Zambezi. In 1920 she went up the river from the Victoria Falls to the Barotse capital Lealui, visiting also several of the stations of the Société des Missions Evangéliques, which this year celebrates its centenary.

Miss Mackintosh's picture of Southern Rhodesia in its pioneer stage is excellent; practically a reproduction of her diary, it vividly reproduces the atmosphere of those early days. Equally good is her description of the river scenery in her second journey; she has the artist's eye and the gift of making word-pictures. The untravelled reader is assured that he is getting a true idea of what the country looks like. This is the author's contribution to geography; the trail she followed is still "new," but others had blazed it. It was to see and study people rather than places that the second journey was undertaken, and we get a picture of the Barotse in their present stage of development which is highly suggestive. We see clearly the change which is coming over native society through contact with Western thought and Western methods, and, in especial, through the introduction of Christianity. Yetta III., the present paramount chief (son and successor of Lewanika), is a Christian, as are many of the sub-chiefs: the influence of the Paris Society's agents and that of the officials of the British South Africa Company are uniformly and successfully directed to raising the status of the people, and as Barotseland is likely always to remain a black man's country, the outcome will probably be a civilized Christian negro land which will exert considerable influence on the future destinies of South-Central Africa. Miss Mackintosh enables us to understand how this movement is shaping.

The book is saturated with the missionary spirit, but there is no trace of the "unctuous rectitude" which so irritated Cecil Rhodes. Instead we get good stories in plenty, humour at once "dry" and refreshing, and a turn of thought which will provoke the reader to examine anew familiar subjects.

F. R. C.

AMERICA

Lewis Evans: his Map of the Middle British Colonies in America.— Henry N. Stevens, F.R.G.S. London: Henry Stevens, Son, & Stiles. 1920. 21*s. net.*

The acquisition of the earlier Evans map of 1749 has been made the occasion for a second edition of the author's booklet issued in 1905 (see *Journal*, vol. 26, p. 334). The new edition not only revises and corrects the notes on the ten maps described in the former work, but includes descriptive notes on the map of 1749, and on eight additional and distinctly derivative maps. The value of the present work is still further enhanced by the facsimile reproduction of five maps (¼-scale), and of the little cartouche of each of the nineteen maps described.

Evans's map made in 1755 was reproduced during half a century in seventeen different maps. Of these two were reproduced in 1776 from the original plate, with alterations and acknowledgment of the original author. The other fifteen were piracies reproduced from two different piratical plates, one of which was altered seven times (1760–1814), the other six times (1765–1800).

By reproducing the following maps, Evans 1749 and 1755, with Pownall's reissue 1776, Kitchin piracy 1755, and the last identified descendant (1796–1800?) of the Bowles piracy of the Kitchin map, the author has supplied the

material for an excellent training in the use and authority of maps as contemporary documents. The series of struggles which marked the second half of the eighteenth century in America created a demand for maps on this side of the Atlantic, while probably the original plate and the men who knew the area were on the other side. "The tricks of trade of map publishers and the plagiarisms of the cartographers of the period" brought out in this excellently produced volume, open a student's eyes to cartographical vagaries, and supply him with new weapons with which to approach all critical cartographical controversies. Comparative cartography as an aid to the elucidation of history is but in its infancy. W. H. B.

The Chinese in British Guiana.— Cecil Clementi. [Georgetown]: The Argosy Company, Ltd. 1915. *Sketch-maps.*

The first suggestion that Chinese labourers might be obtained for the West Indian plantations appears to have been made by a Committee of the House of Commons, who were appointed to consider the subject in 1811. The suggestion was tentative, and no action was taken until the abolition of slavery in 1834 produced a scarcity of labour which compelled the planters to consider new sources of supply. In 1853 the first Chinese labourers under contract were imported, and the importation continued irregularly until 1879 and then ceased. In the following thirty years a few Chinese came as free immigrants. Thus during a period of almost sixty years about 16,000 Chinese came to British Guiana, of whom one-seventh were women. In 1911 the total Chinese population of the colony was less than 3000, the sexes being then in the proportion of 57 per cent. males to 43 per cent. females. The Chinese labourers appear to have given very general satisfaction; the climate was suitable to them and unsuitable to European manual workers, yet the experiment of developing the country by means of imported labour had achieved very small results.

Mr. Clementi has made an admirable study of this experiment—interesting, clear, and searching. His conclusion is as follows: "The Chinese immigration failed as a colonization scheme because it was neither initiated nor yet pursued in the interests of colonization. The planters needed adult male labourers, and were therefore indifferent to the low percentage of females in the Chinese immigration. The labour required by the sugar estates fluctuated; the planters did not, therefore, trouble to maintain that steady annual demand which might have served to accustom the minds of the labouring classes in South China to the idea of emigrating to British Guiana. The planters' chief aim was to obtain the labour they needed as cheaply as possible; they were therefore glad to dispense with back-passages and allotments, in order that the cost of the Chinese immigrant might as far as possible be reduced to that of the East Indian."

It seems clear from Mr. Clementi's story that, had colonization been desired, and had more attention been paid to the human side of the problem of importing labour, as the missionary, Mr. Lobschied, advised, a large Chinese colony might by this time have been established in British Guiana, and the development of this rich province been carried much further than has actually been done. But every student of colonial history is familiar with the clash between the interests of business and of colonization, and a long-sighted policy of colonization is seldom to be expected from a community of planters.

E. A. B.

The Conquest of New Granada, being the Life of Gonzalo Jimenez de Quesada.— R. B. Cunningham Graham. London: Wm. Heinemann. 1922. *Portrait and Map.* 15*s. net.*

In the preface to a book he published in 1912 the late Sir Clements Markham wrote: "I submit the following brief account of Chibcha civilization and of the conquest of New Granada without any thought of its taking a place by the side of the works of Prescott. My intention is far enough from that. Its object is only to stop a gap in English literature until such time as it may be worthily filled by another more detailed work from the pen of some one who is intimately acquainted with all the localities as well as with all the original sources of information, some of which are still undiscovered." The present work by Mr. Cunningham Graham, who, besides being a master of English prose, possesses the desired qualifications noted by Sir Clements, steps worthily into the gap. Perhaps one may not say "fills it," because the narratives and reports that Ximénez de Quesada is known to have written are still hidden away in obscurity, if not irretrievably lost. On this point the student should read first Sir Clements' introductory chapter (nine pages); and next Mr. Cunningham Graham's Appendix II. (five pages), entitled "The Lost Writings of Quesada," before turning to the body of the present book. Fortunately several old chroniclers had the opportunity of studying Quesada's writings, or at least parts of them; and such respectable historians as Hernández de Oviedo, Fernández de Piedrahita, Antonio de Herrera, and Juan Castellanos did not scruple to make free use of his manuscripts in compiling their several historical works. Oviedo, indeed, was a contemporary of Quesada, and knew him in the flesh; he describes him as "un hombre honrado, de gentil entendimiento y muy habil," and relates that he composed his own twenty-four chapters on the subjection of New Granada to the Spanish yoke from conversations he had with Quesada and from the records enshrined in Quesada's manuscripts. One of his narratives the latter lent to Oviedo, in whose possession it was allowed to remain for some considerable while. "It is in these twenty-four chapters" of Oviedo's work, Mr. Cunningham Graham observes, "that the best and most authentic account of the conquest of New Granada is to be found"; though in another place (p. 1) he pronounces Fr. Pedro Simon (author of 'Noticias Historiales') "the most complete authority on the subject."

Early historians differ as to whether Quesada was born at Cordova or at Granada. This discrepancy, as the author remarks, is of little moment; but in mentioning those who put forward the latter view he might have included Herrera, who says cautiously, "era natural, como se dixo, de Granada." We know definitely, however, that whether cradled in the lost city of Boabdil or not, it was there that he was brought up and educated during one of the most critical and romantic stages of its history; and there, too, he graduated and practised as an attorney in association with, or in succession to, his father. In 1535, says Fr. Pedro Simon, by which time Quesada was about thirty-five years of age, he had become an able lawyer and skilful in debate; so that when D. Pedro Fernández de Lugo was appointed to govern the young colony at Santa Marta he selected Quesada to accompany him as chief magistrate, which he did. This move altered the whole manner of Quesada's career: it changed, so to say, his destiny, it directed his first step towards military and political distinction, and it drew forth qualities which merged the lawyer into an explorer, a pioneer geographer, and led him on o victory, to become the founder of Bogotá, and the conqueror or "paci-

ficator" of the country around. His national services were ill requited by the Emperor, owing chiefly to the intrigues of a rascally rival—son of the deceased Governor de Lugo—whereby Quesada was recalled to Spain, fined, and exiled. After wandering about Europe for ten years he returned, in 1550, to Bogotá, where he afterwards had the misfortune to contract a loathsome disease, said to have been leprosy. Yet he lived in retirement to a green old age, and died at Mariquita, in the upper valley of the Magdalena river, in 1579, adored by the populace as a patriarch, but leaving no descendants.

To enable the English reader to understand how these things came to pass, and to preserve the good name (save for one lapse) of Ximénez de Quesada from threatened oblivion, is the purpose of Mr. Cunningham Graham's present volume; and assuredly no living Englishman is better equipped with those qualifications which Sir Clements Markham deemed essential for the task. To them he adds an intimate acquaintance with the Spanish language and temperament, being imbued with all that affability and good will towards the scholars and people of the Peninsula which they love to characterize as *hispanophil*. Here then is a book for whose production the literary world should be grateful; and one which, it may be safely predicted, will have a lasting vogue as the soundest and most thorough authority in our language on the life and character of Quesada and the early history of the Hispano-American State now called Colombia. Mr. Cunningham Graham is to be congratulated on the manner in which he has woven his somewhat heterogeneous materials into a continuous whole, and clothed his phrases with that accustomed grace of diction and aptness of metaphor which every Fellow of this Society who has been privileged to hear him speak at its discussions, or has read his other books, will recall. *Ergo vale, et semper vivas, cultissime Auctor*, as a certain Padre Didaco, of Panamá, exclaimed in olden time when apostrophizing his Bishop, the before-mentioned historian of the same subject—Don Lucas Fernández de Piedrahita. B. G. C.

The Copper and Bronze Ages in South America.— Erland Nordenskiöld. Gothenburg: E. Boktrycheri Aktiebolag. 1921. *Map and Illustrations.*

This is another of Baron Nordenskiöld's ethnographical studies which are throwing so much light on the native peoples of South America and their culture. It deals with a subject of the greatest interest to archæologists, and incidentally raises the question, so largely geographical, of the cultural influence of the Old World on the New in pre-Columbian times. The fundamental questions the author seeks to answer are: Was there a Bronze Age in South America? and if so, was it preceded by an Age of Copper? The result of his researches can leave little doubt that both questions must be answered in the affirmative. His conclusions are based on a study of ancient literature in which reference is made to copper objects since the conquest, on representations of metal objects on pottery and textiles, and on a comparison of types of copper objects of the age of which some conclusion can be drawn from the circumstances under which they were found. The copper and bronze objects considered were very largely collected by the industry of the author, but are supplemented by those in museums.

Points discussed are: where copper and tin were obtained; where bronze was first made in South America; and the nature of the bronze found, as regards the proportion of tin present. There are great differences in percentage of tin, just as in the bronze of the Old World, and in both cases the problem arises whether, when the proportion of tin is very small, its presence may be due simply to the impurity of the copper ore used, or whether the tin

of the alloy was obtained independently. In South America it is not necessary to fall back on the impurity of the ore, for Bolivian copper ores never contain tin, and moreover pure tin has been found, and the purity of the alloy points to the metal and not the ore being used in its manufacture.

The evidence points to the Bronze Age having begun at some period between Incan times and the building of Tiuhanaco. As the author remarks, there is nothing impossible in the idea that Indians responsible for the Tiuhanaco architecture invented bronze, especially as it was not far from that spot that tin existed. Hence knowledge of bronze may have been discovered in Tiuhanaco times, and have reached the coasts of Peru and Ecuador through Tiuhanaco culture, and not first through the Incas.

A chapter is devoted to the interesting problem of the relation of the bronze of the New World to that of the Old, involving the question whether prehistoric metallic culture was introduced into America from the Old World, or arose there independently. In favour of the former view may be mentioned the similarity of Egyptian **T**-shaped axes to those found in South America, and the resemblances of ornamented axes with small holes to those found widely distributed in Asia. In both cultures castings were made by the *cire perdue* method, and in both also gilding and silvering were in vogue. As the author says, there is not much that is entirely original in the bronze and copper tools of South America, yet, he adds, "I doubt whether this is any proof that the Copper and Bronze Ages arose in the New World under the influence of the Old." One type of axe at least was independently invented in South America, viz. the socketed axe, for its development can be traced step by step from **T**-shaped axes and star-shaped club-heads. "If these forms of weapons were independently invented in America, we may wonder whether this was not the case with the other forms of metal tools and weapons." It is also worthy of notice how much more recent the Bronze Age is in the New World than in the Old, the difference being at least 3000 years; for whilst it may be dated approximately at 1500 A.D. in America, it must be put at latest at 1500 B.C. in the Old World. To thoroughly elucidate the problem a fuller study of the metallurgy of Central America and Mexico is desirable, so that we may know whether the Bronze Age is younger or older there than in South America, and to what extent metal culture developed independently or otherwise in different parts of America. It is to be hoped that Baron Nordenskiöld's researches will lead to further discoveries, and thus afford a test of theories which are apt to be advocated with a dogmatism not yet fully justified by the certainly known facts.

In appendices particulars of numerous analyses are given, and the work is fully illustrated with drawings of pottery, metal objects, and graphs, besides two maps showing the distribution of copper and bronze objects.

E. A. PARKYN

AUSTRALASIA AND PACIFIC ISLANDS

South Sea Reminiscences.— T. R. St.-Johnston. London: T. Fisher Unwin, Ltd. 1922. Pp. 209. *Illustrations and Map.* 16*s. net.*

Lieut.-Colonel St.-Johnston is one of those industrious and fortunate individuals who have a habit of making notes, and of afterwards turning them to good account. He is to be congratulated on having diligently exercised this talent in the moments of his official leisure during ten years' residence in Fiji as a medical officer and District Commissioner; and in having woven his material thus acquired into a chatty and entertaining narrative for publication now that the scene of his duties has changed. In Fiji the stock of local

"yarns" has been accumulating for half a century, beginning perforce with the story of Black Bill, an American negro who, in the quality of ship's cook, had deserted or been left in the islands in the old whaling days, and blandly informed the members of Sir Arthur Gordon's staff when His Excellency arrived as first Governor, in 1875, that "I am one ob de fust white man what settled in dis country, yes, Sah." As time wears on the tale of *raconteurs* of Fijian lore grows apace; and the book under notice forms a worthy successor to the volumes of the 'Earl and the Doctor,' of Dr. Litton Forbes, of Hugh Romilly ("Liar Romilly," as some of his friends used to distinguish him), Sir Basil Thomson, Wilfrid Walker, Miss King, and others of unequal experience and merit. Here, however, we have for the first time, in chapter ix., some account of Fijian natives when far removed from their fatherland, the author having come home in medical charge of a contingent of a hundred smart fellows, all keen volunteers and patriots, whom the War Office consented to employ in France and Italy, and whose conduct throughout their service proved a pattern of efficiency and good behaviour. The book is written in a genial, easy vein, and affords altogether lighter reading than the same author's 'Islanders of the Pacific,' in which he discusses the complex question of early Polynesian migrations. As names are mentioned in these 'Reminiscences' without reserve, old residents in the islands should find them no less attractive than will strangers to whom the book may come as an arm-chair solace in winter evenings at home, whether by virtue of the old, and new, stories that intersperse its pages or the interest of the personal narrative that constitutes its framework. The illustrations are good, many of them from original photographs. B. G. C.

GENERAL

Age and Area: A Study in Geographical Distribution and Origin of Species.—J. C. Willis, with chapters by **Hugo de Vries, H. B. Guppy, Mrs. E. M. Reid, James Small.** Cambridge: University Press. 1922. Pp. vii. and 259. *Price* 14*s. net.*

As those who have used his previous books know, Dr. Willis has spent most of his working life in the tropics. His interests have always lain rather in the field than in the laboratory, and his extensive and detailed observations, especially in Ceylon, have led him to the conclusion that much of the work on plant distribution done since Hooker's days has been carried out on wrong lines. This seems to him especially true as regards the current applications of the theory of Natural Selection. He considers that Natural Selection is not a causative and positive agent, but a destructive and negative one, acting chiefly at the moment of origin of a new species. Once established he believes that species tend to travel outwards, with extreme slowness, from the supposed centre of origin. His views are summed up in his 'Age and Area' hypothesis, which may be stated in his own words (p. 63), slightly abbreviated, as follows: The area occupied at any given time, in any given country, by any group of allied species at least ten in number, depends chiefly, so long as conditions remain reasonably constant, upon the age of the species of that group in that country, but may be greatly modified by the presence of natural barriers, by human action and by other causes. The meaning of "age" in this hypothesis is that it is maintained that when one takes long periods of time, and an average of several allied species, the net effect of the active factors, such as dispersal methods and so on, is so uniform, that these species spread indefinitely at a fairly steady rate. Thus by taking groups of ten allies, and comparing with other groups allied to the first, the rate [or degree?] of expansion of area will be a fair measure of age (p. 6).

Of the book as a whole it may be said that, even apart from its highly technical subject-matter, it is difficult to read. In the above condensed quotation the author seems to us to use the word "rate" to cover two slightly different ideas, and there are many other examples of this. Further, its main thesis, more especially in its bearing on the theory of evolution, is outside the geographer's province. It is on this account all the more necessary to insist that the book contains much of direct geographical importance, and is one that the geographer cannot afford to neglect. This importance seems to us to lie in the stress laid upon the physical conditions as the most potent factors in determining biological distributions. For example, every geographer has to recognize, and to attempt to account for, that phenomenon known by the unsatisfactory term of acclimatization. When dealing with such cases as the spread of European or American weeds in Australia at the expense of native plants, the tendency is to accept the view that these plants, being more highly evolved, are better able to survive than the more primitive native types, which go down before them. Dr. Willis rejects this view altogether, and holds that man, by cultivation, clearing, and so forth, has so modified the physical conditions in such areas that the introduced forms cannot be said to be occupying a pre-existing area, but a new one, man-made. Again, in dealing with the larger problems of floral changes in recent geological time, he, and Mrs. Reid, one of his collaborators, discuss in a most interesting fashion the effects of the Ice Age on the flora of Europe. Indirectly this discussion brings out facts, too detailed to be discussed here, which appear to us to be of great geographical importance, as helping to account for the rise of civilization round the Mediterranean Sea.

M. I. NEWBIGIN.

La Terre et l'Évolution Humaine: Introduction Géographique à l'Histoire.—Lucien Febvre, avec le concours de Lionel Bataillon. Paris: La Renaissance du Livre. 1922. Pp. xxvi. and 471. *Sketch-maps. Price* 15 *frs.*

This book forms a member of an elaborate series of volumes on the Evolution of Man, in process of publication under the general editorship of M. Henri Beer. Its preparation, for reasons set forward in detail in the Editor's Preface, has been entrusted to a historian and not to a geographer, and the author in his *Conclusion* states that his book is not a manual nor a general survey, but simply a critical discussion, "that is to say, a permanent conclusion." The nature of the criticism may be gathered from the following quotation: "Necessities nowhere; possibilities everywhere. And man, master of the possibilities, judges of their employment: we must then henceforth place him in the forefront by a necessary reversal: man and no longer the earth, nor climatic influences, nor the determining conditions of place" (p. 284). In other words the book is chiefly an attack on "geographical determinism," and thus on Ratzel and those who have been influenced by that geographer's outlook. Of the dangers of a critical attack on so large a scale the author shows himself thoroughly aware, and defends himself vigorously from possible accusations of indulging in "facile irony," and tilting at windmills; his main line of defence being that even the best-informed and most cautious geographers are continually contradicting themselves, and basing ambitious theories on insufficient premises. He has read widely, if somewhat indiscriminately so far as geography is concerned, and many of his criticisms are both apt and witty; but the cumulative effect is depressing. He disclaims any intention of stirring up one of those "misérables querelles de boutique qui sont la honte, sinon des sciences, du moins trop souvent des savants," but he adds that he is sometimes disposed to think that some kinds of "human geography are perhaps nothing but history

revivified in its sources, rejuvenated in its methods, and happily renewed in its subject-matter." We fear that he has forgotten the significance of the parable of the "méchant animal"; for it seems too much to hope that there will not be geographers able and willing to defend themselves against so caustic an attack, and one which seems to relegate their subject to a quite subordinate position.

M. I. NEWBIGIN.

Henry Hudson's Reize onder Nederlandsche Vlag van Amsterdam naar Nova Zembla, Amerika en terug naar Dartmouth in England, 1609, volgens het journaal van Robert Juet.— Uitgegeven door **S. P. L'Honoré Naber.** *Met* 4 *Kaarten en* 3 *Platen.* 's-Gravenhage: Martinus Nijhoff. 1921.

Henry Hudson's third voyage was undertaken under the auspices of the Dutch East India Company, and therefore an edition of Juet's journal has been issued by the Linschoten-Vereeniging, accompanied by notes and elucidations from the pen of Heer Naber, whose work on the voyages of Barents, Heemskerck, and Rijp was noticed in vol. 55, p. 147. Hudson's voyage was, indeed, intended by its promoters to be a continuation of these explorations, but having in May found the route to the north of Nova Zemlya closed by ice, the navigator immediately directed his course to America in the hope of finding a north-west passage north of the colony of Virginia. It hardly needs Heer Naber's long disquisition to prove that this was a breach of faith on the part of Hudson. The contract he signed is sufficient proof, for by it he was bound to seek a north-east passage north of Nova Zemlya and, whether successful or not, to return immediately and report to the directors.

The principal source of information regarding this voyage, remarkable chiefly for Hudson's well-known exploration of the river which still retains his name, is the journal kept by Robert Juet of Limehouse. This journal has been carefully translated into Dutch by Heer Naber, who has also added a number of very useful notes. He corrects Asher's interpretation of the word "slake," which would make Hudson the earliest discoverer of spots on the sun. On the other hand, his suggestion that the mythical Busse island may be Rockall cannot be accepted. The island was reported to be of considerable size, and Rocol (Rockall) appeared on a map three years earlier, not far from its true position. Heer Naber has also discussed the details of the voyage in a summary, and has collected much information respecting Arctic exploration in Hudson's time, including Plancius' proposal of sailing on a great circle to the Anian strait, with the sectional loxodromes.

The long preface is practically an appendix to Heer Naber's former work on De Veer's narrative, and contains answers to Dr. Burger's criticisms. It is interesting to note that Heer Naber does not believe that Rijp circumnavigated Spitsbergen.

W. A. T.

The World.— **Leonard Brooks, M.A.** University of London Press. 1921. Pp. x. and 360. *7s. 6d.*

Bk. IV. New Regional Geographies.

The Oxford Geographies.— **A. J.** and **F. D. Herbertson.** Oxford: Clarendon Press. New editions, edited and revised by O. J. R. Howarth.

The Preliminary Geography, *2s.*; the Junior Geography, *3s.* Questions on Junior Geography, with Statistical Appendix, *1s.*; The Senior Geography, *3s. 6d.*; Questions with Statistical Appendix, *1s.*; Physiographical Introduction to Geography, *2s.*; The British Empire, *3s.*

Elementary: I. Physiography, *2s.*; II. In and About our Islands, *2s. 6d.*; III. Europe, *2s. 6d.*; IV. Asia, *2s. 6d.*; V. North and Central

America, 2*s.* 6*d.*; VI. The Three Southern Continents; VII. The British Isles, 3*s.*; VIII. Britain Overseas, 3*s.* (Eleanor K. Howarth.)

Clarendon Geography, in 2 vols., 4*s.* each, or 6 parts, 2*s.* each. I. Principles; II. British Isles; III. Europe; IV. Asia; V. Africa and Australasia; VI. America.

Nations of the Modern World.— **Sir H. J. Mackinder, M.A.** London: George Philip & Son. 1921. Pp. xvi. and 328. 3*s.* 6*d.*

No. 5 of Elementary Studies in Geography and History. Fifth edition, completely revised.

The Senior Scientific Geography.— **Ellis W. Heaton, B.Sc.** London: Herbert Russell. 1910. Pp. 874. 8*s.* 6*d. net.*

Reprinted 1921. With appendices dealing with the territorial changes brought about by the war. Also in parts, *e.g.* Bk. II. Europe, 2*s.*; Bk. VII. The British Empire, 3*s.* 4*d.*

The Junior Scientific Geography. Bk. III. The British Empire, 1911. 2*s.* 4*d. net.*

With appendix dealing with territorial changes caused by the war.

A Regional Geography of the Six Continents.— **Ellis W. Heaton, B.Sc.** London: Herbert Russell. Bk. I. Europe, 1914, with appendix, 1921, 2*s.*; Bk. IV. Africa, 1919, 1*s.* 4*d.*; Bk. V. Australasia, 1921, 1*s.* 3*d.*

A Progressive Course of Comparative Geography.— **P. H. L'Estrange, B.A.** London: George Philip & Son. 1922. Demy quarto. 15*s. net.*

Ninth edition, revised and enlarged, with 76 pages of maps, 168 pages of letterpress; in six separate parts, 2*s.* 6*d.* each. The maps and text are also issued separately as A Progressive Atlas of Comparative Geography, 9*s. net*, and A Progressive Course of Comparative Geography, 6*s.* 6*d. net.*

A Text-Book of Geography.— **G. Cecil Fry, M.Sc.** London: University Tutorial Press. 1921. Pp. xxiv. and 527. 6*s.* 6*d.*

Fourth edition, revised and enlarged.

The World. London: Longmans, Green & Co. 1921. Pp. x. and 613. 7*s.* 6*d.*

New edition, "with subject-matter and maps in accordance with the terms of the Peace Treaty."

Geography for Senior Classes.— **E. Marsden** and **T. Alford Smith.** London: Macmillan & Co., Ltd. 1921. Pp. 521. 7*s.* 6*d.*

Human Geographies.— **Fairgrieve** and **Young.** London: George Philip & Son.

Primary Series: Bk. I. Children Far Away, 1*s.* 6*d.*; Bk. II. Homes Far Away, 1*s.* 6*d.*; Bk. III. British Isles, 1*s.* 9*d.*; Bk. IV. In the New World, 1*s.* 9*d.*; Bk. V. In the Old World, 2*s.*; Bk. VI. Europe and Britain, 2*s.* 6*d.*

Secondary Series: Bk. I. The British Isles, 2*s.* 9*d.*

Edina Geographies.— **T. Franklin.** Edinburgh: W. & A. K. Johnston. Bk. I. British Isles, 1*s.* 8*d.*; Bk. II. Europe, 1*s.* 9*d.*; Bk. III. Asia, 1*s.* 8*d.*; Bk. IV. Africa, 1*s.* 8*d.*

Arnold's Modern Geographies.— **A. A. Davey, M. A.** London: Edward Arnold. Bk. III. Europe and the Mediterranean, 9*d.*

Geography of the Homeland.— **R. J. Finch.** London: Evans Bros. N.D. 4*s.* 6*d.*

An Introduction to Applied Geography.— **A. Stevens, M.A., B Sc.** London: Blackie & Son. 1921. Pp. x. and 309. 6*s.*

A Sketch-map Geography.— **E. G. R. Taylor, B.Sc.** London: Methuen & Co., Ltd. 5*s.*

Open-Air Geography and Topographical Modelling: an Introduction to Field Geography and Army Drawing.— **J. W. T. Vinall** and **G. Linton Snaith.** London: Blackie & Son. 1920. 5*s.*

Recent changes in the political and academic world have dealt hardly with the reissue of geographical text-books published before the war. Many of the new editions have adjusted the political and economic balances by additional notes, paragraphs, and appendices to previous reprints. But the teaching of geographical science has undergone changes of late years that give a great advantage to books of recent publication. Sir Halford J. Mackinder and the late Prof. Herbertson have done much towards shaping the form of modern geographical thought, and therefore the reissue of the 'Oxford Geographies' and 'Elementary Studies in Geography and History,' with their material brought up to date, is to be welcomed.

Of the books which are essentially a product of the new teaching, special mention might be made of the 'Human Geographies and the 'New Regional Geographies,' which have many excellent features. It is recognized that the physical laws underlie geographical phenomena, and 'Applied Geography,' which deals largely with what used to be called mathematical and physical geography, is of value as giving material in simple form, which must be applied continuously to the distribution of geographical phenomena.

It is fully recognized, too, that the study and use of maps form an essential part of geographical education, and under certain circumstances even elementary surveying and field sketching may be a useful school study, in which case one can recommend such books as 'Open-Air Geography.' To depict by sketch or diagram the results of geographical study is almost as valuable as being able to read maps. For this purpose 'A Sketch-map Geography' is useful, if it is used merely to show methods, and not as a geographical "cram."

The reissue of 'A Progressive Course of Comparative Geography' is welcomed, for though it does not give the fulness of reading which in certain schools is essential, it supplies map studies and exercises which afford excellent geographical training.* W. H. B.

A Geography of the Bible.— **Eleanor K. Howarth.** Oxford: The Clarendon Press. 1922. Pp. 96. *With a Sketch-map of Palestine and* 16 *Illustrations from Photographs.* 2*s. net.*

This little handbook gives in eight chapters a condensed account of the great "Bible lands"—Palestine and Syria, Egypt, Babylonia, Asia Minor, and Greece. For convenience of the teacher or lecturer it is further divided into 103 short sections, each of which might be appropriately illustrated in practice by special lantern slides. The broad facts of historical geography in these lands are presented in a readable form, and there are few errors or obscurities. As a school textbook to place in the hands of the pupils it can be thoroughly recommended, but the teacher would be wise to supplement this information from other sources, as the process of condensation has necessarily led to the exclusion of much that is of interest. E. W. G. M.

* The above list of recent text-books does not profess to be exhaustive, and several others have been received since this review has been in type.—ED. *G.J.*

THE MONTHLY RECORD

EUROPE

The Iron-ore Resources of Europe.

In a recently published Bulletin (No. 706, Washington, 1922) of the United States Geological Survey, fully provided with maps, charts, and other illustrations, Mr. Max Roesler aims at supplying a summary of the iron-ore reserves of Europe. It is a compilation based on the published work of the best authorities, and gives not only reserves but statistics of production and consumption. An introductory chapter gives a few useful and necessary definitions and deals with the general aspects of the subject by way of explanation. The reserves are classified throughout as (1) "known ore," (2) "probable ore," and (3) "possible ore." "Known ore" is defined as ore or developed material that can be profitably mined under present conditions. "Probable ore" is material that is likely to be mined in the future. "Possible ore" includes material not workable as ore at present, either on account of its conditions of occurrence or on account of inferior quality, but which may possibly become workable as conditions change. The chief items in the total reserves of Europe (12,405 million tons of iron) are as follows:

France	35·2 per cent.
United Kingdom	18·2 ,,
Sweden	12·5 ,,
German Republic	11·1 ,,
Russia (including Ukraine)	8·3 ,,
Spain	5·0 ,,
Other countries	9·7 ,,

The reserves of the world as a whole are not so well known as those of Europe, but it is surmised that the reserves of Europe are not more than about one-seventh those of the world as a whole. On this basis it is estimated that the world's available supply of iron would last more than a thousand years at the rate of consumption prevailing in 1913. If consumption increased at the pre-war rate (25 per cent. in every five years) the supply would be exhausted in about 130 years; but it does not seem probable that this rate of increase will be maintained. T. C.

ASIA

The Sea Route to Siberia.

The question of the opening of a regular sea-route to Siberia is bound to come once more to the fore whenever there is a return to stable government in Russia, and the summary of our knowledge of the question lately given in the *Russian Economist* (vol. 2, No. 6) by W. L. Bogdanovitch is therefore of interest. The opening of the sea-route, towards which considerable advance had been made in the years preceding the war, has acquired a still greater importance owing to the complete collapse of the Russian railway system, and even since the armistice some practical use has been made of it for the transport of supplies from the Siberian rivers. In 1919 a steamer was sent from England and another from Sweden in addition to nine vessels sent from Archangel, while the well-known ice-navigator, Captain V. A. Vilkitsky, made a reconnaissance of the ice in the ice-breaker *Taimyr* and marked out the fairway through Yugor Strait. The mouths of the Obi and Yenesei were marked beforehand by beacons and lights, and the vessels were met on arrival by pilots. The

atmosphere of civil war prevented the transhipment of the whole cargo prepared, but besides other goods 2500 tons of grain were brought to Archangel. In 1920 eleven Russian steamers, with barges, etc., in tow, made the voyage successfully in two groups, one of which reached Nachodka bay without seeing ice at all, and cargoes of grain, furs, etc., were again brought to Archangel. Ice reconnaissance was again carried out by the *Taimyr*. Last year the enterprise was repeated, and though two vessels were lost (one of them very old) large cargoes were brought back. The writer of the memoir goes fully into the conditions which prevail on the route as established with more or less certainty by the observations of the last decades, showing that the only obstacles to be encountered are accumulations of ice driven about by the wind, and not a solid ice-pack. The provision of wireless apparatus has greatly lessened the chances of failure to make the passage, for it rarely if ever happens that all the passages are closed at the same time, while the rapid movements of the ice often quickly clears those that have been temporarily blocked. A summary is given of the number of attempts made by the several routes, and it is stated that on the whole the failures have borne but a small proportion to the successes, and that many have been due to want of perseverance after the first difficulty presented itself. It is held that in favourable years the navigation may be considered open for three months, whilst in unfavourable ones the time may be reduced to from 1½ to 2 months. It may therefore be possible for well-equipped vessels to make the voyage twice within one season. M. Bogdanovitch, who seems to have studied the whole question with care, also discusses possible improvements in methods of transhipment on the Siberian rivers, and the comparative merits of the sea and land routes between northern Siberia and Europe.

The Ganges in Hindu Literature and Legend: Changes in its Course.

In a series of articles contributed to the *Indian Antiquary* for 1921, of which a reprint has been received from the author, Mr. Nundolal Dey attempts to elucidate the changes which have taken place in the course and termination of the Ganges since ancient times from a study of literary references and Hindu legend. The larger part of the study is concerned with changes in the delta and its seaward advance in the course of centuries, but it begins by a discussion of the general course of the river as hinted at in allegorical manner in the ancient legends associated with it. The ancient writings—the Râmáyana, the Mahâbhârata, and the Puranas—agree as to the main outlines of the story, according to which the Goddess Gaṅgâ was brought down from heaven by Bagîratha to obtain salvation for the sixty thousand sons of Sagara, who had been reduced to ashes by the curse of the ascetic Kapila Muni, at whose hermitage, Sâgara-saṅgama or Kapila-âśrama, the fall of the river into the ocean is always placed. The accounts also agree as to the river's origin in the Himalayas in three streams or sets of streams by which Gaṅgâ was supposed to have escaped from the matted hair of Mahâdeva (represented by the ice-clad and corrugated sides of the mountains of Garhwal); and in the junction of the Gaṅga (or Bhâgîrathî), the Yamunâ, and (as was supposed) the Sarasvati, at the site of Allahabad. This junction —one of the three specially sacred points in the river's course—had its counterpart in the supposed separation of the same three rivers in the delta, where the same three names recur, a fact which must be remembered if confusion is to be avoided.

Although the point where the Ganges empties itself into the ocean is always spoken of as Gaṅgâ-Sâgara or Kapilâśrama, this must not be taken to be a fixed point, for as the delta advanced so did the position of the sacred

spot. There is evidence to show that in the second century A.D. the head of the Bay of Bengal reached to near the present site of Calcutta, now about 80 miles from the sea, while in the seventh century Tamluk, now 60 miles from the ocean, was a maritime port. The five mouths of the Ganges mentioned by Ptolemy must therefore have occupied positions much higher up than the present mouths. The writer has no doubt that Ptolemy's name Kambyson, given to the westernmost mouth, is a transcription of Kapilâśrama ; the mention of a place Polura near it enables him to place the mouth at that period at Samudragadi near Kolapura (the ancient name of which means "Entrance into the ocean") in the Nadia district. In the same way an attempt is made to elucidate Ptolemy's other data, including his mention of Gange, capital of the Gangarides—evidently, Mr. Dey thinks, a corruption of Gaṅga-Râḍi, derived from the country of Râḍha, now part of Bengal. Various considerations lead to the identification of Gange with Saptagrâma or Sâtgâon, which was a flourishing emporium from the beginning of our era to the sixteenth century. In the time of Megasthenes the capital of Râḍha was Parthalis, identified with Purvasthadi, a very old and large village in the Burdwan district. The southward shifting of the capital in the interval of five or six centuries is probably another indication of the extension of the delta seawards. Its emergence from the sea is also indicated by the very names of places, such as Nava-dvîpa, or New Island (modern Nadia), Chakradaha, or the Circling Whirlpool (modern Chakda), and Śhushkasâgara, or the Dried-up Sea (modern Suksagor). Evidence is also adduced of the shifting of channels within the delta, the present main channel—the Paddâ or Padmâ—having existed only as a spillway before the sixteenth century, the main outlet having previously been by the Bhâgîrathî to the Hugli. It was, no doubt, the diversion of the main stream to the Padmâ that first caused the deterioration of the Hugli, a process that has continued to the present day.

AFRICA

The Survey and Mapping of Madagascar.

In the *Renseignements Coloniaux* published hy the Comité de l'Afrique Française (No. 12, 1921), Commandant E. de Martonne gives a useful summary of the activities of the Official Survey department in Madagascar from 1910 to 1920, and takes stock of the present position of the mapping of the island. He had some years ago given a similar report of progress down to 1910 in the *Annales de Géographie*, vol. 19, pp. 46-69. Down to 1906 the work was carried out by a Bureau Topographique acting in association with the Service Géographique de l'Armée, but in the year named it was transferred to a newly organized Service Géographique de Madagascar, which soon took in hand a map on the scale of 1/100,000, the general map in twenty-two sheets on that of 1/500,000 having become inadequate for the growing needs of the colony. While the direction of the Service Géographique is in military hands, as is also the survey work in the field, there is a civil department for the drawing and printing of the maps. In the latter branch remarkable results have been gained from the employment of natives, only two European supervisors being retained, while all the actual work of drawing, photography, engraving, and printing is done by Malagasy, who show great skill and aptitude. The chief difficulty has arisen from the fluctuating amount of the sums voted for carrying on the work, which in 1912 seemed threatened with entire suspension by reason of the sudden withdrawal of aid from the general Colonial budget. This disaster was however averted by the provision of funds from the local budget,

and even during the war the work never ceased entirely. The continuity so secured was of great advantage when it was possible to resume more active work after the war. The 1/100,000 map will eventually comprise 508 sheets, each 30 × 48 cm., but its completion must obviously be the work of years, and only the most important regions can be dealt with at first. The projection chosen is Bonne's conventional, or the modified Flamsteed, with axes crossing not far from Tananarivo. The field work follows the usual methods of the Service Géographique de l'Armée, and is plotted on the scale of the final map. The necessary subsidiary triangulation is carried out each year by geodesists in the districts to be covered the next year by the topographers. It depends itself on the geodetic net of the first order completed during the years 1897–1906, which is not of the highest degree of precision, but which it is hoped to improve in course of time. In 1911 after some delay the geodesists were provided with more precise instruments, and started the measurement of a base of 9462 metres outside Tananarivo, afterwards proceeding to the operations for a meridional chain of the first order from Tananarivo to Majunga on the north-west coast. The work was carried out by Captain Carrier (killed during the war), and is said to have been the most precise yet done in any of the French colonies. Meanwhile the topographical and cartographical work has progressed steadily, and thirty-three sheets of the 1/100,000 map are already on sale. It is printed in six colours from zinc plates. For the less important districts the compilation of a 1/200,000 map has been taken in hand, and of this a dozen sheets, covering a considerable area in the south-east, have been issued. The six sheets of the 1/M map have also been completely revised.

AMERICA

The Mackenzie River Oilfields.

We have received from Mr. F. H. Kitto, an engineer under the orders of the Canadian Department of the Interior, various type-written reports dealing with the Natural Resources of the north-west of Canada, and among them is one on the Mackenzie River Oilfields, which is useful as supplying an unbiassed review of the present position and prospects of that region from the point of view of oil-production, as to which there has been much extravagant talk, not justified by the facts. While during the boom of the early part of 1921 the idea was current that vast quantities of oil were waiting to be tapped and that enormous and quick returns might be expected, it is now evident that the development of the Mackenzie oilfield must be a slow and gradual process. Still it is held that there is no cause for disappointment if it is realized that over-sanguine anticipations had never been justified, particularly in view of the remoteness of the field and the difficulties of transport. Interest at present centres on the Discovery well worked by the Imperial Oil Company, situated on the right bank of the Mackenzie about 45 miles below Norman. This does actually produce oil, and that of a very high grade, though in limited quantities. Bores have been put down at other points with varying results (one reaching a depth of 1500 feet before operations had to be suspended for the time), and drilling was thought likely to be actively prosecuted during 1922, the capabilities of the field being thereby more adequately tested. One result of the rush to the Mackenzie has been to call attention to its apparent potentialities as a mineral-producing area, prospecting having pointed to the occurrence of placer-gold, gold-bearing quartz, and silver, lead, zinc, copper, and iron ores. In view of actual and prospective activity measures have been taken by the Government to provide the necessary organization of the region by opening a Mining

Recording Office, by strengthening the forces of the mounted police, and by executing surveys of the whole system of waterways forming the main artery of the region. Besides the banks of the Mackenzie itself to some 75 or 100 miles below Norman, the Slave river to Great Slave lake, the south shore of this lake, and about 40 miles of Bear river, making up about 2000 miles in all, were accurately charted and linked on to well-established points. The Geological Survey of Canada has taken steps to study and map the structure of the country. At the same time something has been done by the trading and transportation companies responsible for the business of the district to cope with the increased requirements. The Hudson's Bay and Northern Trading Companies have overhauled their boats and increased their carrying capacity, and the portage from Fitzgerald to Fort Smith made necessary by the rapids on Slave river has been put into comparatively good shape. On the Peace river the portage at Vermillion chutes remains a serious drawback, and on the Athabasca the uncompleted section of the Alberta Great Waterways Railway necessitates a haul by waggon for 3 or 4 miles from the railhead to Clearwater river, but the early opening of the railway to McMurray at the junction of the latter with the Athabasca, to which steamers can ascend at all seasons, was anticipated, as also improvement in the operation of existing lines.

The Rainfall of Chile.

What is claimed to be the first detailed account of the distribution of rainfall in Chile is given by Mr. Mark Jefferson in Research Series No. 7, of the American Geographical Society of New York (1921). Within the territory there is, of course, comprised the extreme of aridity in the north and of wetness in the south, and it is in the transition belt between 31° and 38° S. that the chief cities are situated, and where the interior valleys between the coastal range and the Andes, being neither desert nor forest country, are most suitable for agriculture. While the rainfall steadily increases from north to south it is found that in all except the rainless desert latitudes the interior valleys are drier than the windward or western slopes of the coastal mountains, and drier still than the western slopes of the Andes. In the cultivated valleys of the middle populated zone the rainfall varies from well under 20 inches a year in the north to over 50 in the south, while along the coast it increases from 20 inches at Valparaiso to over 80 at Valdivia. As the more northern rainfall is practically confined to the winter months (Mediterranean seasonal type) irrigation is necessary for agriculture in the fertile interior valleys, but with unlimited supplies of water descending from the Andes this can hardly be accounted a serious drawback. On the western or windward slopes of the Andes the rainfall is heavier than on the corresponding slopes of the coastal range because of the greater orographic effect upon the moist Pacific winds, and it is pointed out that the bottoms of the deep Andean valleys receive an increment due not merely to their own elevation but also to the lofty ridges in which they are set. Criticism is passed on Voss's rainfall map of Chile (1907), which is based on very scanty material with practically no data from interior stations, and consequently shows a quite fallacious continuous decrease of rainfall from the Argentine plains towards the Chilean coast. On the Andean slopes in the central zone and along the coast in the extreme south the annual rainfall approximates to 200 inches. The rainless zone of northern Chile and Peru has been discovered from ships' observations to extend only one or two hundred miles out to sea, appearing to keep to the Humboldt current.

AUSTRALASIA AND PACIFIC ISLANDS

The Census of Fiji.

The Census Report of the Colony of Fiji for 1921 was laid upon the table in May last under the modest designation "Council Paper No. 2." In reality it forms a solid blue-book of 190 pages foolscap, and affords much interesting matter for anthropologists, statists, and old residents in the islands—not to say politicians—to think over. Two cardinal facts, say the compilers, emerge from the mass of statistical information obtained by the census, namely that (1) the condition of the Fijian native population is now such as may reasonably lead to a belief that the continued decrease of the race is being arrested; and (2) that the circumstances of life among the Indian immigrants and their descendants in the Colony have not, in spite of much criticism, been such as to retard a substantial increase in their numbers. The first of these statements, it is to be feared, must be characterized as optimistic, and will remain open to question so long as pandemic influenza haunts the world. As to the second, the Fiji-born Indian appears to be differing in character and physique in some degree from his progenitors and relations in Asia, and not for the worse by any means.

Including the dependency of Rotuma, with its little-varying population of 1052 male and 1060 female natives, the total population of the colony in April 1921 was as follows: 157,266 persons, made up of Europeans and other whites 3878, half-castes 2781, Fijians proper 84,475 (of whom only 40,453 were females), Indians 60,634 (of whom only 23,619 were females—due to immigration of an excess of males), Melanesians 1564, Rotumans 2235 (of whom 123 were resident in Fiji proper, and the sexes were about equal), Chinese 910 (of whom only 65 were females), and miscellaneous other persons 789. The report bears evidence of having been drawn up with much care and is a credit to the compilers, the printers, and the administration, not forgetting a small army of native and Indian clerks and local officials who did their share of the enumeration and returns. The blue-book contains at the end a complete index of all the native villages and districts, with the names of the Provinces in which they are respectively situated. This has been drawn up and revised with minute care, and is intended to serve not only as a reference list to particulars contained in the volume, but as a standard register of the correct spelling of the names in accordance with the native system of orthography, which differs from the R.G.S.2 method.

MATHEMATICAL AND PHYSICAL GEOGRAPHY

The Sargasso Sea and Ocean Currents.

In reference to the note on the Sargasso Sea in the *Journal* for June last (p. 476), in which Captain Dixon's observations on the quantity of weed present per square mile were described, Commander Soley writes pointing out that a good deal of information on the Sargasso Sea is supplied in the current charts issued by the U.S. Hydrographic Office, for the preparation of which he has been responsible for a number of years. The extent of the weed-covered area and its nature as an area of relatively still water in the centre of an encircling current is well shown in the coloured chart of the circulation of the North Atlantic for February and August, and the general conditions are described in the letterpress accompanying the general chart of the Circulation of the North and South Atlantic Oceans. Still more detail is given in the chart of the

circulation in the North Atlantic for the month of May. At its greatest extent, about August, the weed-covered area stretches from about 23° to 40° N., with a maximum longitudinal extension from about 40° to 70° W. By the end of the year the amount has greatly diminished through gradual disintegration of the weed. Commander Soley sends us an interesting photograph showing five stages in the deterioration of the weed, from samples picked up some years ago by Captain Wood of the S.S. *Etonian*. After it reaches the fifth stage it disintegrates and sinks. Commander Soley hopes before long to print a current chart of the world showing the arterial system all over the oceans, and says that he has just finished the chart of the Indian Ocean, in the preparation of which he has been led to the unorthodox conclusion that the monsoons are not to be considered as a causal agency of the currents.

GENERAL

The Sources of Potash.

A new edition of a pamphlet by Mr. S. J. Johnstone describing the sources of potash has lately been issued under the auspices of the Imperial Institute (London: John Murray, 1922. Pp. 122. 6*s. net*). Potash is of a special interest as a very useful commodity of which Germany had a monopoly before the recent war, for almost the whole of the world's supply was at that time obtained from the famous Stassfurt salt deposits. Such deposits have a remarkably restricted distribution. They occur in Alsace, but the Alsatian deposits were controlled by Germans before the war. The restoration of Alsace to France broke the German monopoly, and it is interesting to notice that, of the total world's output of about 1,171,000 tons of potash (potassium oxide) for 1920, Alsace produced about 17 per cent., against about 79 per cent. produced in Germany. Although German and French deposits together yield about 96 per cent. of the world's output of potash, their description is covered in eight pages in this pamphlet, the main part of which is given to the numerous other possible sources of supply, animal, vegetable, and mineral, which, although they contribute little to the world's trade in potash, are of much interest as sources of supply in localities where they are available. These include lake salts, nitrates of organic origin, sea-water, flue-dust in cement kilns and blast furnaces, seaweed, wood-ash, and wool-washings. Reference is made to the interesting developments that took place during the war, when agriculture and other industries in countries outside Germany suffered seriously through being deprived of their normal supplies of potash. The pamphlet includes a bibliography.

T. C.

Memorial to R. E. Peary.

The *National Geographic Magazine* for June 1922 contains the account of the dedication in the previous April of a memorial erected by the National Geographic Society in Arlington National Cemetery, Washington, in honour of Robert E. Peary. The gathering on this occasion included the President of the United States and Mrs. Harding, Chief Justice Taft, the Secretary of State, the Secretary of the Navy, Captain Robert A. Bartlett, Peary's companion on his expedition to the Pole, and other prominent persons. An introductory address was delivered by Dr. Gilbert Grosvenor, President of the National Geographic Society, and tributes to the explorer were also paid by the Secretary of the Navy (Edwin Denby), and the Assistant Secretary (Colonel Theodore Roosevelt), the monument being afterwards unveiled by the explorer's daughter, Mrs. Edward Stafford (born within the Arctic circle), his

widow being also a guest of honour at the ceremony. The monument, of which a photograph is given, consists of a globe of white Maine granite (on which the continents are carved in low relief) resting on a solid granite base bearing suitable inscriptions, headed by the Latin motto "Inveniam viam aut faciam" (I will find a way or make one).

OBITUARY

Major H. V. Hesketh-Prichard, D.S.O., M.C.

By the death of Major Hesketh-Prichard, in June of this year, a personality has passed away whose talents and achievements in the field of travel and exploration might have been more fully recognized had they not formed but a part of an unusual number of different claims to distinction. To one group of Englishmen his almost gigantic frame was most familiar on the cricket-field, where he figured in county and first-class matches for many years, with a formidable reputation as a bowler. To another section of the community he appealed as a highly successful writer of fiction; his best-known creation, the bandit hero Don Q., attaining the distinction, very rare among characters of its class, of being referred to and thought of almost as an actually living person. Prichard's gifts as an author also lent a rare charm to his descriptions of his travels and hunting expeditions, and to some of his friends it was, indeed, almost matter for regret that his popularity with the readers of magazine stories prevented the full revelation of talents of a higher order of which he was undoubtedly possessed. Most of all, perhaps, do his services in the war, to which his last fatal illness was directly attributable, merit not only the distinctions which he actually obtained, but a permanent place in the grateful recollections of his countrymen. Through all, and above all, of these sides of a versatile career, he should be thought of as a sportsman born and bred, in the very highest sense of a word rarely so correctly applied.

Hesketh-Prichard was born in India in 1876, and the premature death of his father, an officer in the King's Own Scottish Borderers, left his early training entirely in the hands of his mother. It is really remarkable, and reflects the utmost credit on both the parties concerned, that the only son of a widowed mother should have developed a character of such conspicuous and unspoiled virility. While from first to last the relations between mother and son were of the closest description, and they were life-long collaborators in literature, the boy was from the first encouraged to follow his own bent irrespective of risk, and his travels began almost as soon as he came of age. In 1899 he visited the Negro republic of Haiti, in search of interesting matter for the newly established *Daily Express*, making extensive journeys in the little-known interior of the island, and even witnessing certain quasi-pagan ceremonies which few white men have been privileged to observe so closely. Fortunately the numerous warnings received as to the dangerous character of this early venture proved largely unfounded, though on one occasion an attempt was made to poison the explorer's flask. Immediately after his return Prichard was chosen to lead an expedition to Patagonia, to investigate the possible survival of the giant sloth. Though no evidence was found to suggest the continued existence of this creature, a quantity of information was brought back regarding the lesser-known regions of the country and the native

inhabitants, which was imparted to the public in a book of exceptional interest.

For some years after this expedition Prichard's activities as a traveller were mainly confined to hunting trips after big game, in the pursuit of which he excelled, having the hunter's instinct developed to a rare degree, and being, in the writer's opinion, almost unsurpassable as a rifle-shot under sporting conditions. This gift proved of the greatest value when, during the war, he started the systematic education of the army in sniping and observation, an idea the origination of which must be recognized as almost exclusively his own.

In 1910 Prichard resumed the rôle of an explorer, putting into practice a long-cherished project by penetrating into the interior of Labrador over an unknown route of his own choosing, as far as the Indian House lake on the George river. But for the war and his untimely death, he would undoubtedly have had other achievements of a similar description to his credit. His genial temper, sound judgment, and generally attractive personality render his loss a matter of very special regret to all who were privileged to enjoy his friendship.

Lord Northcliffe.

Lord Northcliffe, who died at his London residence on August 14 last, aged fifty-seven, had been a Fellow of the Royal Geographical Society for twenty-eight years, having been elected in 1894, the year in which he acquired the *Evening News*. It is obviously impossible in this Journal to deal with the many and varied public interests of his strenuous life, and we can only refer briefly to those which brought him into special contact with geography. He had travelled extensively and always showed a special interest in the opening up of "new" countries and the improvement of means of communication in lands old and new. When Dr. Nansen was engaged in the *Fram* expedition, Mr. Harmsworth (as he then was) financed the expedition of Mr. F. G. Jackson to Franz Josef Land, which sailed in 1894 and returned in 1897. The Jackson–Harmsworth expedition did much good work, and it may be recalled that in June 1896 Jackson met Nansen and Johansen and that the Norwegians returned home in the Jackson relief ship the *Windward*. This ship Mr. Harmsworth afterwards presented to Admiral (then Lieut.) Peary, who used it in his 1898–1902 expedition. Lord Northcliffe, as indicated, was always interested in new methods of locomotion, and did much to promote motoring and aviation. It was with his cordial support that in 1920 Dr. Chalmers Mitchell, on behalf of *The Times*, made the first attempt to fly from Cairo to the Cape.